DISCOVER'S

20 THINGS

YOU DIDN'T KNOW

ABOUT EVERYTHING

DUCT TAPE, AIRPORT SECURITY, YOUR BODY, SEX IN SPACE . . . AND MORE!

BY THE EDITORS OF

DISCOVER MAGAZINE AND DEAN CHRISTOPHER

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20 Things You Didn't KNOW ABOUT EVERYTHING

By the Editors of DISCOVER Magazine and Dean Christopher

With Reporting by Jason Stahl

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PREFACE

First off, apologies for the title. We know, it's absurd. *20 Things You Didn't Know About Everything*, indeed! For one thing, there are surely many more than 20 things that you—like all of us—don't know about any one thing. On another level, it's obvious to anyone smart enough to read the title that no book can possibly contain even one thing you don't know about every single thing! That way lies infinity, madness, an impossibly bulky volume. Imagine the cost of paper, ink, printing, shipping. We never meant to be taken literally, so a little slack is clearly in order.

But you did pick up the book. Chances are it was for one of two reasons: (1) you're inherently curious or (2) you want to prove us wrong, because you're used to knowing just about everything.

Either way, this book can be useful to you.

Aristotle wrote that whenever our minds expand to encompass new ideas or information, they never shrink back to their original dimensions. Even if the information is faulty, even if the ideas are rejected, once stretched, consciousness tends to stay stretched.

So consider this book an entertaining, relaxing way to stretch your mind. We designed it to be interesting, informative, and fun to read, whether you skip around or (for the highly structured)

churn through from front to back. It's not a textbook, not a collection of learned monographs. So if you're a specialist in some topic listed here, seeking fresh esoterica in your particular field, you should probably put this down and buy some other book. No harm done; maybe our next book will be more up your alley.

A quick word about "facts." By the time you finish this book (depending, of course, on when you buy it and how quickly you read), some—perhaps even all—time-sensitive information may be outdated. Biggest, Fastest, Most Advanced—all those "facts" evaporate as new records are set. Planets get discovered, one "greatest disaster" supersedes another, unexpected diseases and treatments emerge, and so forth. Anyone who deals with science, technology, and the future (as *Discover* magazine does—see our cover) lives in a world that's constantly being updated and reinvented by eager scientists, technologists, and futurologists who strive constantly to prove themselves (or even better, to prove others) wrong.

So take *20 Things You Didn't Know About Everything* with a smidge of sodium chloride (NaCl). Read it at your leisure. Expand your mind. Exercise your abs by laughing at anecdotes and quotes from people both famous and forgotten. You'll probably find much here to amuse you and add perspective to those things you already know. As far as we know, everything in these pages is true. Or, as the Italians like to point out, even if it isn't true, it ought to be.

Happy reading.

—The Editors

20 THINGS YOU DIDN'T KNOW ABOUT AIRPORT SECURITY

I think arriving at or departing from any airport in America is just horrendous these days.

—*ROGER MOORE, British actor*

Anyone who travels by air has good reason to be concerned. Besides post-9/11 jitters, we increasingly hear reports of flaws in the air traffic system, overworked flight controllers, computer failures at peak traffic hours, near misses in the air and on the ground.

One carefully underreported threat (don't panic the customers) is shoulder-fired surface-to-air missiles—easy to operate, inexpensive, and readily available—presently impossible for civilian airliners to defend against. Our airplanes are, if not sitting, at least slow-flying ducks for terrorists.

Cited again and again is incompetence at all levels of the agencies tasked with aviation security. Most "security measures" supposedly in place to protect air travelers are highly cosmetic. Officials at the highest levels proclaim that "the government is doing everything in its power to counter terrorism." We hope that this brief review of airport security—or lack thereof—will move readers to demand genuine, efficient action from people who know what they are doing.

There is little doubt that the main terrorist threat is not box cutters, daggers, or handguns but explosive devices. These are either obtained on the open market or improvised ("home cooked") by an ever-growing cadre of skilled amateur bomb makers. There are endless ways to blow things up, limited only by imagination and opportunity. The terrorists' slogan: "You have to thwart us 100% of the time. We have to succeed only once."

All security people, and all people who fly, are constantly aware of this. But it's impossible to protect every target every moment of every day. So we gather the best intelligence we can, deploy our most advanced technology and assessment tools, and pray the terrorists will make mistakes. How long this strategy can keep us safe is anybody's guess.

* * *

1. THE VUITTON WENT BOOM. The vast majority of terror killings on airlines are by bombs hidden in checked luggage. To date, less than half of all checked baggage (and almost no cargo) is screened for explosives.

El Al Airlines, with the world's most efficient security, is often consulted for anti-terror advice. In 1987 an Israeli expert drafted a thorough security plan for Pan American Airways. It involved profiling passengers, hiring only professional security staff (not minimum-wage high school dropouts), and carefully inspecting all carry-on items, checked baggage, and hold cargo.

The company rejected the idea as "overly expensive" and "intrusive to passengers." A year later, Pan Am Flight 103 exploded over Lockerbie, Scotland—from a bomb in unin-

spected checked baggage. Pan Am soon after went out of business.

As long as airlines continue to gamble with passengers' safety just for the sake of stockholders' dividends, we are all in danger.

According to the Department of Homeland Security, about 730 million people travel on commercial airliners each year. More than 700 million pieces of their baggage are screened for explosives and other dangerous items—or so they claim.

Of course, we should all be aware of what we're packing in our carry-on luggage—anything that might be considered dangerous could be confiscated at a security checkpoint.

—*DAVID NEELEMAN, founder, JetBlue Airways*

2. LADIES AND GENTLEMEN, WHEN BOARDING, PLEASE DO NOT CARRY OR WEAR ANYTHING.

On average, 1 in 17 passengers is carrying what the FAA terms a "dangerous item." The TSA's loose definition of "potential weapons" includes hairspray and ballpoint pens. Extra-heavy jewelry is prohibited. Grandma's old iron brooch could be used to club a pilot; big pins, rings, cufflinks, lanyards, bracelets, or necklaces just might . . .

Clothing with snaps=suspicion! Also, ornate belt buckles, bras with wire reinforcements (discrimination against the ample-bosomed?)—and whose throat could Tiffany's tin

butterfly barrette slash? Passengers with body piercings get close screening—even pat-downs or body searches—depending upon what has been pierced and how dramatically.

If anyone wonders why the airlines are not doing well it is because flying has been made such an unpleasant and degrading experience.

—KEITH HENSON, U.S. scientist

3. PEEK-A-BOO, I SEE YOU! (And maybe your hidden explosives.) Orlando International Airport has installed Rapiscan Secure 1000, a full-body X-ray device that allows screeners to see through clothing. And Sky Harbor International Airport in Phoenix is testing its own system, the Backscatter, designed to scan passengers' bodies for dangerous things.

Privacy advocates are resisting these snoop technologies, delaying their inclusion in America's arsenal of anti-terrorist security devices. The ACLU says that use of the Rapiscan Secure 1000 amounts to unlawful strip search. And transgendered passengers have a set of problems all their own.

The X-ray machines can identify most known plastic or liquid explosives as well as non-metallic weapons that are often—indeed, usually—missed by the metal detectors currently in service. Sensitive to modesty issues, the Transportation Security Administration is working to adjust Backscatter's imaging to blur private areas while remaining clear in places most likely to harbor threats. Won't this just encourage terrorists to conceal weapons in the body areas most likely to be blurred?

Increased and better screening for explosives is necessary—and Congress should fund it and TSA should implement it as quickly as possible. However, that screening doesn't reduce the risk posed by a trained terrorist with an unconventional weapon.

—DAVE REICHERT, U.S. politician

4. BEYOND SMART MACHINES. Boston's Logan International Airport has become the first U.S. airport to go beyond technology and focus on human factors. Their "behavior pattern recognition" (BPR) program was created for Israel's Ben Gurion Airport to identify suspects who may have mayhem in mind. Now Logan has trained more than 100 Massachusetts State Police in BPR to enhance security in and around the airport.

America needs to know who our enemies are and what they plan to do. Improving our intelligence capacity is essential to ensuring the safety and well-being of all our citizens.

—TODD AKIN, U.S. politician

Troopers look for odd behavior, like wearing heavy clothes on very hot days, buying long-distance tickets without luggage, acting overly nervous or overly detached. In all those cases, the behavior may be perfectly innocent. What is important is that it would attract attention and lead to a casual interview by a trooper.

People are free to refuse to talk to troopers. But that guarantees more stringent scrutiny at security checkpoints.

Officers are trained to be friendly and cheerful, to keep the subject at ease and off guard. Bland questions might include

"How'd you like Boston? What did you see there? How about those Red Sox?" etc. Meanwhile the trooper checks identification, tickets, and passport and asks follow-up questions to verify the initial answers.

If anything heightens suspicion, the trooper will alert TSA for closer attention at the screening point. If the situation heats up, the subject may be refused boarding or, in extreme cases, arrested.

Interviews of all suspicious-looking individuals are noted, with a description of the person, and forwarded to the Joint Terrorism Task Force, which can then share that information as needed with other security entities.

The Logan BPR project includes interviews not just inside terminals but in parking lots, along walkways, and at random roadblocks at access roads.

5. GETTING IT RIGHT. The screening process for Israel's El Al Airlines takes from two to three hours. Most passengers are interrogated for about 30 minutes before boarding. This is feasible because Israel's airports handle only a fraction of the traffic that passes each day through busy U.S. and European terminals.

Efficiency is doing things right; effectiveness is doing the right things.

—*PETER DRUCKER,*
U.S. business consultant

6. WEAR YOUR CLEANEST SOCKS. Regulations require all passengers to remove their shoes for security inspection. Since 2001, hundreds of millions of travelers—and about twice as many feet—have been subjected to this tedious precaution because of one lunatic's botched attempt to destroy a transatlantic flight with explosives hidden in his sneakers.

Richard Reed, the "shoe bomber," is serving a life sentence for eight charges, including attempted mass murder. However, after almost seven years of shoe searching, not one has been found to contain anything more dangerous than jellied insoles.

7. SEE SPOT, ER, SPOT. The TSA's program called Screening of Passengers by Observation Techniques (SPOT) is "non-intrusive behavior observation" designed to, uh, spot potentially high-risk passengers. Based on known behavior analysis techniques, it supposedly weeds out travelers who show symptoms of terrorist or criminal intent.

Who is a threat, and who is just scared, drunk, or acting weird? The Shadow knows—doesn't he? As a deterrent, the TSA's SPOT program adds an element of unpredictability to the security screening process to make it theoretically harder for terrorists to slip through security. SPOT is currently in use at over a dozen major U.S. airports. But, if we know this, don't the terrorists know it? Won't they just start using "minor" airports?

8. HOW YOU LOOK VS. HOW YOU ACT. Police and security people are often accused of overly screening certain ethnic groups. "Reasonable suspicion" is a legally acceptable basis

for interrogation. But some say that officials are unreasonably suspicious, based on stereotyping. The challenge: to balance behavior pattern recognition with civil liberty concerns and still stay safe.

Racial profiling—even if it weren't controversial—is of minimal value for security. Although Arabs were Israel's enemy, the worst attack on Ben Gurion Airport was carried out by Japanese terrorists in 1972. To focus on ethnic Muslims (the most obvious example) is to invite attacks from other unexpected ethnic groups.

Even though some in our government may claim that civil liberties must be compromised in order to protect the public, we must be wary of what we are giving up in the name of fighting terrorism.

—*LUCILLE ROYBAL-ALLARD,*
U.S. congresswoman

9. ON GUARD FOR PEANUTS. In 2001, the average starting wage for U.S. airport security screeners was under $6 an hour. Fast-food workers in the same airports averaged $7 an hour. That year, the turnover rate of security workers at our largest airports was 126%. We don't know the turnover rate of the fast-food workers.

According to the TSA Web site employment link tsacareers.com, security screening candidates require a high school diploma, GED or equivalent (what's the equivalent of a certificate that's already an equivalent?), OR "at least one year of full-time work experience in security work, aviation screener work, or X-ray technician work."

The job description is quite clear:

[CANDIDATES must] work within a stressful environment, which includes noise from alarms, machinery, and people; distractions; time pressure; disruptive and angry passengers; and the requirement to identify and locate potentially life-threatening devices and devices intended on creating massive destruction. Make effective decisions in both crisis and routine situations.

Sounds like a perfectly awful way to make a scanty living. Which way to the fast-food application?

10. NON-DAIRY CREAMER OF THE CROP. Security screeners must be U.S. citizens or naturalized citizens, proficient in English. They are expected to have mental abilities, including "visual observation and identification" (useful for spotting bombs and RPGs) and a quality mysteriously described as "mental rotation"—the ability to twist their minds around spinning ideas?

It is heartening to know that decent vision and hearing are part of screeners' skill sets, with "adequate joint mobility." Nervous passengers will be encouraged by their protectors' rigorous training: "56–72 hours of classroom training and 112–128 hours of on-the-job training." That's one week to nine days of security education, and 14 to 16 days of supervised hands-on experience!

I've been in situations where I've gotten a little nervous, or when I haven't flown for a while, before I'm driving to the airport, I get a little twinge of anticipation.

—*HARRISON FORD, U.S. actor*

We wonder why.

11. FOCUS, FOCUS. Before the federal government began to oversee airport security, the Transportation Department's Inspector General managed to slip knives past screeners in 70% of the tests he ran. Now only 24% of the knives make it through. Still far too many.

After 9/11, airport security personnel overlooked National Guardsmen's machine guns that were passed through X-ray machines. Apparently what they were trained to look for was bombs. Any fool knows that assault rifles don't look like bombs. On the first anniversary of 9/11, CBS news producers tried to carry X-ray–proof lead-lined bags through security in several U.S. airports. They succeeded 70% of the time.

There are some legitimate security issues, but I believe many of the objections the administration is making are not for security reasons, but to disguise mistakes that were made prior to Sept. 11.

—BOB GRAHAM, U.S. politician

12. FACE FACTS. The human face has about 80 "landmarks," which include the size of the cheekbones and eyes, and unique characteristics about the bridge and tip of the nose.

Face recognition technology is designed to be unintrusive and fast. No hands placed on scanners, no lasers in the eye. Face recognition systems take pictures of faces as people enter or pass an area. The technology is theoretically impossible to defeat, because it mathematically compares facial proportions and structural elements that are hard to disguise.

It works with the most obvious individual identifier—the human face.

When it works. Which it doesn't always do.

For example, one system tested by the Tampa police flopped. Using the Florida open-records law, the ACLU acquired system logs proving that the system failed to identify one single crook or pervert posted on the department's photo database. At the same time, on several dates in 2001, the operators indicated 14 possible criminal matches—all false alarms.

13. HIDE IN PLAIN SIGHT. According to Belgian police, 19,050 blank Belgian passports were stolen between 1990 and 2002. As of 2002, fewer than 1% had been recovered.

Airline uniforms, airport security ID badges, and even police uniforms are regularly reported missing. Who are the people most likely to want such items? That's right. And our airports rarely inspect workers and other personnel wandering around the tarmac and in baggage areas.

Identification documents are the last opportunity to ensure that people are who they say they are.

—*LAMAR S. SMITH, U.S. politician*

And they are so easily forged or stolen.

14. THE SWEET SMELL OF SECURITY. To create breeds ever more capable of sniffing out drugs and bombs, Russian scientists have cross-bred wild jackals with domestic dogs. Next they should consider training bees (see chapter on Bees).

Sniffer dogs have a sense of smell so sharp that they can discriminate particular scents even among competing smells. In 2002, an Australian dog sniffed out drugs a woman was trying to smuggle into a prison in her bra. The stash was disguised with pepper, coffee, and even Vicks VapoRub.

The EADS Corporate Research Centre (CRC) near Munich has been developing a sensor that's smaller than a book and 30 times more sensitive than a sniffer dog's nose. Dogs' sense of smell is 1,000 times more sensitive than humans, and they can be trained to detect a great many substances. But they have limits. After about half an hour, dogs need time to recharge their noses. Machines keep on sniffing and sniffing and sniffing.

Two ace drug-sniffing dogs at Bangkok airport have been relieved of duty after relieving themselves repeatedly on suitcases and humping the legs of female passengers. The pair, part of a program to convert strays into productive police dogs, were good at detecting banned or dangerous substances. But frequent complaints about their gutter-snipe behavior led to their dismissal from the force and reassignment to herding duty on a pig and poultry farm.

15. KEEPING UP WITH THE MATSUMOTOS. To speed security clearance, a Japanese company has developed the Frequent Flyers Bra, which replaces underwiring with resinous supports and non-metallic hooks. Will terrorists develop bra-bombs with resinous supports and non-metallic detonators?

The only gossip I'm interested in is things from the Weekly World News—*"Woman's bra bursts, 11 injured." That kind of thing.*

—*JOHNNY DEPP, U.S. actor*

16. CHERCHEZ LA PERSONNE. One hurdle in developing effective security countermeasures is attitudinal. We typically look for weapons, not for people who want to harm us. The worst terrorist attack in U.S. history—9/11—was not initiated with weapons but by men with box cutters and the desire to murder.

The lesson here—stop the person and you stop the attack—has still not been learned. The U.S. government continues to spend untold billions developing technology designed to detect weapons—but extremely little on techniques and training to ferret out troublemakers at our airports.

Mr. Speaker, we can never forget that the very first victim on September 11, 2001, was a flight attendant, sliced by a box cutter our lax security measures allowed on board.

—*ROBERT BRADY,*
U.S. congressman

17. SECURITY IS WHERE WE FIND IT. Recently three local fishermen had trouble handling their raft on the Hudson River, and they drifted along to the shoreline at JFK Airport in New York. Splashing ashore, they wandered around runways and cargo areas for an hour. No one noticed or questioned the trio. Finally they stopped a policeman for help.

In a separate incident a month later, a New York man hid inside a cargo container and shipped himself by air to Dallas.

This shows, in the words of one airline security expert, "These airports put 10 locks on the front door but leave the back door open."

And let us be frank: the security threats that emanate from our ports come from foreign cargo.

—*DANA ROHRABACHER,*
U.S. congressman

18. AIR MARSHALS—FACT OR FANTASY? If all else fails to prevent evildoers from boarding your flight, you have one final hope: the federal air marshal who may—or far more likely may not—be aboard. Supposedly indistinguishable from ordinary travelers, marshals are authorized to carry guns, make arrests, and use lethal force if necessary.

The exact number of active air marshals is classified and might be as low as zero, knowing the government's fondness for public relations and cosmetic gestures! Some estimate that as few as 5% of U.S. flights have a marshal on board, presumably favoring the routes terrorists would find most tempting.

The air marshal program is under scrutiny by the General Accounting Office. The need to prepare additional marshals quickly has resulted in less training time. The program has been further hamstrung by—ready for this one?—budget cuts! So much for federal interest in security in the sky. Adding to the program's woes: a recent investigation by the Department of Homeland Security turned up 753 reports of "air marshal misconduct" during one eight-month period in 2002, including drunken behavior and sleeping on duty.

19. DON'T OVERLOOK THE OBVIOUS. The first line of defense for airport security is literally a line—an anti-personnel chain-link fence (possibly electrified), high walls, or other barriers. These should encircle the entire airport: baggage, maintenance, and supply areas as well as fuel depots.

Armed security patrols, accompanied by attack dogs, should be supported by electronic surveillance that constantly videotapes the perimeter, supervised by 24-hour trained personnel at a security center. All access gates should be closely monitored by guard stations and surveillance cameras.

To what extent is this done at our airports—even the major international hubs? Answer: minimally to not at all. We seem to think that all problems can be thwarted in the departure lounges.

An increasing risk comes from the growing number of suicide bombers willing to drive a car or truck into a terminal or fuel area and then detonate it. These people will not be deterred by a white-gloved policeman holding up his hand to make them halt.

Huge concrete barriers and blast screens must be deployed around sensitive areas to prevent such intrusion. Parking lots and baggage claim areas are also vulnerable.

20. BETTER LATE THAN TOO LATE. The House Science and Technology Subcommittee on Space and Aeronautics approved a bill authorizing increased R&D funding for airport surveillance and security. This legislation (H.R. 2698) frees up $1.8 billion over the next four years to develop security measures under the guidance of the FAA.

The bill, with wide bipartisan support, was passed on June 22, 2007, by the full committee. We shall see if we put our money where our concern is.

* * *

TO BE SAFE OR SAFER, THAT IS THE OPTION

How far are we willing to go for security? That depends on what happens next. Another 9/11 would probably do one of two things: make the country amenable to even more dictatorial anti-Constitutional measures than those recently implemented, or show that crushing our national freedoms does not, in fact, prevent terrorists from attacking. It only harms the fabric of our republic and what we stand for.

Any society that would give up a little liberty to gain a little security will deserve neither and lose both.

—BENJAMIN FRANKLIN,
American statesman

20 THINGS YOU DIDN'T KNOW ABOUT ALIENS

My own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose.

—J.B.S. HALDANE,
British geneticist

What do we know, what can we know, about aliens—including whether they exist at all? Since there's no fossil record to study, we turn to the warehouse of popular wisdom.

THUMBNAIL ALIEN BESTIARY

Sci-fi's sensational depictions of aliens often feature spooky machines overhead, vaporizing our cities, monuments, and pets at will. Controversial "factual" accounts chronicle trips to distant planets, hosted by (sometimes hospitable) aliens. Descriptions of the crews of these machines are exotic in both fiction and reportage. Alien taxonomy reveals several major categories:

- Genderless, Chinless Kewpie Dolls. The most frequently described aliens are grayish or greenish beings. They arrived in unimaginable ways from unimaginably far

away, perhaps in another dimension—maybe even from the future. They are smaller and smarter than we are. They have dazzling technology, bitsy earholes, bulging crania, and wide-angle Foster Grant eyes. They wear seamless Reynolds Wrap coveralls, glide like angels or insects, and have an odd fondness for prodding our tenders with intrusive implements.

- Masters of Disguise Among Us. Believers tremble at the ET genius for assuming any desired form. From a spore, a blob of goop, or a pod they transmute into little Robby next door, his spaniel Biffy, kindly old Mrs. Fallucci in the corner knitting shop—even the placid *Mimosa pudica* on your porch or a dust bunny beneath your sofa. Their agenda: convert us into mindless slaves, guinea pigs, or late-night snacks.
- Sinister Microörganisms in the Air, in Our Bloodstreams. This is the "Virus—Teeny Invader From Spaces" clique. Believers point to unearthly physical oddities (viruses can act alive or dead depending upon circumstances, adapt quickly to outside threats, go "retro," etc.). Some survive conditions unimaginable for earthly creatures. We find viruses in meteorites—literal "invasions from outer space"—even if it is a unicellular invasion that does not speak with a creepy metallic voice. (What would a unicellular voice sound like? Can it be heard only by unicellular ears?)
- Not "Life As We Know It." This view of aliens contends that there is no way to be sure we could even recognize them. They are undetectable either by our personal perceptory equipment or by our machines. This is the most paranoid view of all regarding alien life—probably also the most likely.

Somewhere between folklore, superstition, overactive imagination, sensationalism, wishful thinking, hallucination, deliberate fiction, mass psychosis, and established reality lies much territory for scientific investigation. How do scientists deal with "extraterrestrial visits," "UFOs," "alien abductions," "intelligent life in the universe"—with whatever may be out there?

Answer: scientific disciplines approach those issues with various tools: psychology, exobiology, optical and radio astronomy, physics, mathematics, and sometimes even philosophy and cultural anthropology.

* * *

1. WELL, THAT NARROWS IT DOWN A BIT. Astronomers Margaret Turnbull and Jill Tarter of the Carnegie Institution in Washington, DC, have compiled a list of 17,129 nearby stars most likely to have planets that could support complex life—not single cells but higher plants and animals. According to Turnbull, stars must be at least 3 billion years old for complex life to evolve. Planets where this is likely to happen must also have low mass and high levels of iron, since metals are needed to form earthlike planets.

It is not enough for a planet to have water and sufficient minerals and be within a certain temperature range. It also needs billions of years of consistent radiation from its star—a stable brightness—to incubate life beyond the unicellular level.

- Jill Tarter holds an engineering physics degree from Cornell and a master's and Ph.D. in astronomy from UC Berkeley. Active in the Search for Extra-Terrestrial Intelligence (SETI) for over two decades, Dr. Tarter is the inspiration for the Jodie Foster character in the film *Contact.*
- Margaret Turnbull is an assistant astronomer at the Space Telescope Science Institute, a former post-doctoral researcher at Washington's Carnegie Institution, and an astronomer with NASA's Astrobiology Institute. Dr. Turnbull has worked with Tarter to catalogue the most likely locations for habitable planets, and she made SETI search recommendations for the forthcoming Allen Telescope Array.

Bingo! In April 2007, astronomers discovered the "most earth-like planet yet" on one of the 100 stars closest to Earth, a mere 20.5 light years out. As galactic distances go, 120 trillion miles is a mere hop. The planet, dubbed "581-c" (third rock from "red dwarf" star Gliese 581), has an estimated surface temperature between 32°F and 104°F—which means the possibility of water and life as we know it.

Although hundreds of planets have been discovered in the past few years, none had a positive "Goldilocks effect"—all were too hot or too cold. But "581-c" is just right. This combination of life-giving water and life-supporting temperature makes it an intriguing target for further investigation. Stay tuned.

2. COME OUT, COME OUT, WHEREVER YOU ARE. A Gallup poll in the late 1990s revealed that about a third of all Americans

believe aliens have visited us—an increase of 5% over the previous decade. The Mutual UFO Network Web site states: "according to a Roper poll conducted in 2002 for the Sci-Fi Channel, one in seven Americans say they or someone they know has had an experience involving a UFO."

A U.S. population approaching 300 million means roughly 100,000,000 Americans who believe in visitors, and 43,000,000 who know someone with alleged first-hand or second-hand evidence.

But if aliens have made contact, when and where, and where are they now? Why don't they stick around? There's no convincing proof of visits—only stories, hints, suppositions. No artifacts, footprints, or indisputable photo evidence. Why leave no calling card unless they wished to remain undetected? (And why would they wish to remain undetected?)

3. CAN YOU DETECT ME NOW? Among other notables, several U.S. presidents have either seen UFOs or had access to information about them. But so far none has made a definite statement yea or nay.

- Bill Holden, a steward on board *Air Force One* with John F. Kennedy, once asked JFK what he thought about UFOs. The president replied cannily, "I'd like to tell the public about the alien situation, but my hands are tied." By whom?
- Jimmy Carter said, at the 1976 Southern Governor's Conference, "I don't laugh at people . . . when they say they've seen UFOs. I've seen one myself. . . . It was big, it was very bright, it changed colors and was about the size of the moon." He promised to make all UFO

secrets available to the public if he ever became president. Well, he did . . . but then he didn't. Why not?

The American public deserves a better explanation than that thus far given by the U.S. Air Force. I strongly recommend . . . a committee investigation of the UFO phenomena. I think we owe it to the people to establish credibility regarding UFOs and to produce the greatest possible enlightenment on the subject.

—*GERALD FORD, U.S. president*

- Ronald Reagan saw a UFO while he was governor of California. A bright white light accompanied his plane, zigzagging around it for several minutes before suddenly whooshing straight up out of sight. Reagan reported the incident to his wife but never mentioned it publicly for fear of being labeled a nut case. Years later, during a private screening of *ET,* Reagan reportedly turned to Steven Spielberg and whispered, "Only a handful of people know the truth about this."

What about UFO crews? At least one president is supposed to have been in on the secret.

- The widow of legendary TV comedian and actor Jackie Gleason claims that Gleason, known for his obsession with UFOs, was invited by golfing buddy President Nixon for a secret late-night visit to Homestead Air Force Base in Florida. There, Gleason confided to friends, they saw the remains of some half dozen wizened child-size humanoids. Some were mauled, as if they had been in an accident. The creatures had

three or four fingers. Gleason was disturbed and excited by these beings, who were clearly "not human." But he never understood why our government would hide the aliens from the public.

Astronomers only cautiously comment on the probability of life elsewhere in the universe, even in "our local corner of the Milky Way."

Scientists avoid sensationalism, since voicing hot-button opinions can damage reputations and derail careers. Few universities award professorships, or even grants—let alone tenure—to loonies who support ideas like aliens already here, humans mating with offworlders, secret interplanetary power-sharing deals. Hence the lukewarm assessments of the probability of contact with alien life any time soon.

For one thing, galactic distances (as we understand the idea) are unimaginably vast. Even traveling near the speed of light, journeys to all but the nearest stars would take longer than humans currently live. Such trips would take hundreds, even thousands, of Earth years. Even one-way visits would require revolutionary improvements in spaceships, astronauts, and equipment—solutions to fundamental problems of physics and human biology. Not to mention human boredom.

And even assuming a return to Earth, it would not be the Earth the travelers had left behind, but one inhabited by very distant descendants.

4. WHAT'S THE FREQUENCY, FRANK? Astronomer Frank Drake made the first scientific attempt to contact alien beings in 1960, with an 85-foot-radius dish at the National

Radio Astronomy Observatory in West Virginia to listen to signals from two nearby sun-like stars. So far his search has turned up zilch.

But can we be sure? Maybe they're cheerfully yammering at us in their version of the King's English (the Xpptfffl's Bz-rkkfnn), but our sense organs cannot perceive the signals they are sending. Or if they do, we primitives don't recognize it as language. We assume that our thinking matches extraterrestrial thinking. This presupposes—probably incorrectly—that logic and the grammar of perception are the same everywhere. SETI scientists keep scrubbing the skies for signals representing prime numbers, the hydrogen molecule signature, and other "obvious" things we know. But ideas that are meaningful to us may be too primitive for (or irrelevant to) advanced minds.

Dr. Frank Drake is the founder of SETI and creator of the Drake Equation, a formula for calculating the probability of intelligent technological civilizations in the universe capable of communication. He is a titanic presence in the search community and a pioneer radio astronomer, directing SETI research starting with Project Ozma in West Virginia in the early 1960s and continuing at the megadish radio telescope in Arecibo, Puerto Rico. In 1972 he and Carl Sagan designed the Pioneer Plaque, the first "note in a bottle" ever sent by earthlings beyond the solar system. Since then he has taught and he is honored as the father of our planet's outreach to the stars.

5. NOSE JOB, BOOB JOB, INTELLIGENCE JOB. If we make contact with extraterrestrial intelligence, how can we tell

whether it is living, feeling, sentient organic being's intelligence we are experiencing, or artificial intelligence?

We all receive auto-responses to phone calls and e-mails. "This is Dolores. I'm away until the twenty-fifth. Leave a message at the beep." If mere humans can create this response to an electronic stimulus, greatly advanced civilizations may have greatly advanced programs designed for similar purposes. One can imagine civilizations so advanced that they are connected to a constantly expanding network of thousands, even millions, of others across the universe.

Most life on Earth is not even life as we know it. . . . Human life is a minuscule branch of the tree of life.

—SARA VIA, professor,
University of Maryland

6. MAYBE HE KNOWS ZAGER AND EVANS. Seth Shostak, senior astronomer at SETI, reckons—for reasons best known to him—that the 350-foot antenna Allen telescope array, now being built, "will trip across a signal by the year 2025."

Dr. Shostak, an imaginative lecturer and media personality, is also noted in reference sources as the inventor of the electrical banana. We do not know what an electrical banana is or does. He is a skilled computer animator. These accomplishments and others may have provided him with a predictive insight that exceeds the ordinary. It is unclear how he arrived at the year 2025.

Extraordinary claims require extraordinary evidence.

—CARL SAGAN,
U.S. astronomer

7. WE'RE HIGH ON SPACE. Astronomers are optimistic about the Allen Telescope Array, the latest advance in SETI, endowed by a grant from Microsoft co-founder Paul Allen. A joint operation of SETI and the Radio Astronomy Lab at the University of California, Berkeley, the ATA will enhance the search effort by a factor of one hundred by being available to SETI 24/7, instead of the limited time available on other galaxy tools.

Rather than one huge collector, the ATA, when completed, will be an ingenious interconnection of 350 6.1-meter antennas, 2,135 cumulative meters in diameter, with a signal scooping capacity of more than 7,000 feet (a mile and a third!) across.

Because it will scan many directions at once, the ATA's collection potential is greater than that of any existing instrument, even the giant 305-meter dish antenna in Arecibo, Puerto Rico. Its wide-angle capability can target many stars simultaneously, boosting signal collection capacity from today's 1,000 to 100,000—and eventually ONE MILLION star systems!

8. TRY THIS AT HOME. You can download software from the SETI@home project (setiathome.berkeley.edu) to sift for alien signals from your home computer. Over 187,000 other people have already done so.

Connecting with alien signals requires huge computing power to allow searches to cover a wide range of radio frequencies. SETI needs all the computing power it can get.

Government funding and dedicated supercomputers are at a premium, so SETI seeks public help in the daily scutwork of data analysis. In 1995, David Gedye suggested orga-

nizing a private array of home computers into a virtual supercomputer. Thus the SETI@home project, begun in May 1999, began to bring this vision to life.

SETI@home is privately funded, largely by the Planetary Society, a non-profit organization co-founded by Carl Sagan. Their search area is the 2.5-megahertz bandwidth, freeing up the rest of the vast radio spectrum to be searched by others.

9. LOCATION, LOCATION, LOCATION. The most likely spots for alien life in our solar system is underground on Mars, the hot spot on Saturn's moon Enceladus (its South Pole is dotted with geysers), and Jupiter's moons Europa and Callisto, whose icy crusts may conceal vast underlying oceans of water.

Speaking of icy, one marine bacterium (Colwellia 34H) sporting around in the Arctic ocean not only survives but burns enough energy to reproduce—at MINUS 196 Celsius. Talk about sexual determination at the cellular level! That's weather on the Martian surface, or in the liquid methane rivers of Saturn's moon Titan. This little bug would be right at home either place, theorizes microbiologist Dr. Karen Junge of the University of Washington's Department of Earth and Space Sciences and NASA's Astrobiology Institute.

Imagination is more important than knowledge.

—ALBERT EINSTEIN, German scientist

10. HEY, HOTEP—DIDJA SEE THAT? Perhaps the earliest UFO sighting occurred in 1450 B.C., when Egyptians saw bright circles of light in the sky. Some UFO obsessives interpret Ezekiel:1 in the Bible as a UFO report.

Ezekiel describes the beings he saw (four wings, four faces, etc.), plus flaming wheels and hoopla. Landing craft? Probes? Hallucination? It is interesting how Ezekiel's aliens (or angels or devils) differ from more recent historical accounts of little gray smooth unspectacular individuals, emerging from quietly humming or whooshing craft.

What if UFOs are not, as we assume, vehicles, but organisms from an evolution based not on carbon but on iron, silicon, or neon? Or even electrons? Flowers? Gamma rays? What if UFOs are writing implements, musical instruments, or other tools from cultures we can't imagine?

Most people who believe in extraterrestrials assume they're from advanced civilizations on other planets. They can get here; we can't go there. Rats! Our frustration is like the sixteenth-century Aztec frustration with Spaniards—creatures from inconceivably far away—who walked among them. Indeed, Spaniards did more than walk among the Aztecs. They slept among them. Similarly, interbreeding and sexual experimentation constitute a popular variation of the alien invasion theory.

11. BLAME IT ON THE BOSSA NOVA. In 1957, Antonio Vilas Boas, a Brazilian farmer, reported that he was abducted by barking aliens, who covered him in gel and mated with him.

Barking? Barking? Another account of the same incident describes the seducer as an attractive naked blonde humanoid woman—entirely un-doglike—who growled. But did she take him to dinner first?

Many sexual abductions seem to involve farmers, men on fishing expeditions, or rural folks. Is that because aliens prefer to operate in remote areas with less likelihood of detec-

tion or interference? Because their rural prey have a healthy outdoor look?

Some alien attacks are even more frightening than sex.

- On the evening of August 21, 1955, at the Sutton farm near Kelly-Hopkinsville, Kentucky, a family and house guests—11 in all—fought off an apparent attack by strange little beings who arrived in a glowing UFO. Described as 3- to 4-foot-tall creatures with huge eyes, minimal mouths, slender short legs, and clawlike hands, they approached the house, whereupon the frightened family opened fire with hunting rifles. The bullets had no effect. The battle continued all night, with the family finally driving away for help. Police found no aliens, only bullet holes and spent shells. After the officers left, the aliens returned to continue the siege. Subsequent Air Force investigations found no solid evidence of aliens, and many dismissed the incident as a hoax. But the Suttons and their guests were not drunks, and they had no reason to damage their home just for a prank. Several witnesses, interviewed separately, drew sketches of the aliens that were remarkably similar. Many now believe that the event happened as described.
- One well-documented multiple abduction occurred in the Allagash waterway, in northern Maine, one night in August, 1976, when four friends were canoe fishing. They saw a gleaming UFO hovering above the tree line, about 80 feet in diameter, changing colors: green, red, yellow. When one man signaled with his flashlight, the UFO swooped down toward the terrified men, who paddled frantically toward shore. A blinding beam of light from the UFO engulfed them and their

canoe. The next thing they recall is being on the bank at their campsite, their blazing bonfire unaccountably reduced to glowing ashes. Obviously, they were missing several hours of their lives. They didn't talk about it. Once home, the men began having nightmares. They were put under regressive hypnosis, and a composite story emerged. Humanoid beings with metallic eyes and insect-like claws had abducted them and subjected them to physical examinations—even removing bodily fluids—before returning them to the ground. By chance, all four were trained artists (friends since art school), and they drew vivid sketches of the aliens, the examination room, and implements the aliens used. All four men passed a lie detector test. Verdict: who knows?

- Skywatch International and the National UFO Reporting Center investigated a spooky incident on the night of September 27, 2000, when four hunters camping in the Idaho forests were terrorized by an enormous (football-field-sized) triangular ship hovering in the sky above their heads, flashing lights. When it whooshed away "like a hockey puck gliding over ice," they broke camp and whooshed away to a motel several hours' drive away. Official explanation: "Unexplained." (Note: A Google Earth photo taken from space is claimed by some to show just such a triangular craft over Western Australia, allegedly checking out a "secret U.S. military base." The photo may be doctored, and the base may not exist, but on the other hand . . .)

12. WISHFUL THINKING? In a 2003 Harvard study, 70% of self-professed abductees stated under hypnosis that they had

been used for breeding or sexual experiments by their alien captors.

These accounts parallel medieval reports of men seduced by succubi or women violated by incubi. Many historical, folkloric, and biblical accounts show remarkable similarities between reported activities of demons, angels, fairies, or other spirits . . . and aliens. Mythology has many legends of "gods and goddesses" mating with humans.

Many UFO "abductees" reveal their experiences under hypnosis. This is not proof that the abduction really happened; it only shows that subjects believe the experience was real.

According to Harvard psychologist Susan Clancy, hypnosis makes it easier for people not only to recall experiences but also to construct "false memories." This is largely because hypnosis "stimulates the imagination and relaxes reality constraints," she suggests.

First thing I wonder . . . is how these aliens can be so stupid. If they're smart enough to fly between the stars as easily as we fly from D.C. to Montana, they should be able to figure out our basic anatomy. But during just about every abduction, it takes them hours to figure out that our navels are not our reproductive organs. Why don't they share that information with other ships? Why do they find our bellybuttons so fascinating?

—*DR. TOM HOLTZ,*
University of Maryland paleontologist,
interviewed by Alta Walker,
Skeptical Enquirer *(Nov/Dec 1996)*

13. HARD TO SEE THE CONNECTION, BUT . . . Allen Cheyne, a psychologist at the University of Waterloo in Ontario, says

that those who believe they've been abducted by aliens are often prone to experiencing sleep paralysis.

As reported in the *Washington Post* (11/20/2005), psychologist Frederick V. Malmstrom, visiting scholar at the Air Force Academy, notes that most self-proclaimed alien abductees describe their captors about the same way: little creatures with big heads and eyes, virtually no mouth or ears, grayish skin, smooth features.

He suggests that they may be unconsciously describing the "prototypical female face" as seen through a newborn's fuzzy vision, which tends to diffuse facial features into blurry blobs—like huge, wide-angle alien eyes. This facial template is in the brain's hard wiring, designed to enhance a baby's bonding with the mother. It is a survival mechanism, much as newly hatched chicks instinctively flee from shadows shaped like predators.

But what is Mommy doing in a UFO? Is that perception a subconscious yearning for the protection of her apron?

14. C'MON, GET IT OFF YOUR CHEST. In Newfoundland, sleep paralysis is called the "old hag" because it is associated with visions of an elderly woman crouching on the sleeper's chest. In the West Indies, the phenomenon is said to occur when a ghost baby bounces on the snoozer.

Aliens are the ghost or devil stories of modern times. All cultures have some version of the creature "pressing down" or "sitting on" the victim's chest. But why are so many of these apparitions "hags" or old women?

15. IN SPACE, NO ONE CAN HEAR YOU SNEEZE. *Streptococcus mitis*, a bacterium that infects the nose and throat, was inad-

vertently sent to the moon aboard the Surveyor 3 probe. The bugs were still alive when *Apollo 12* astronauts retrieved the probe's camera two and a half years later.

Bugs live. And stuff gets around—even alien stuff. Recently Godfrey Louis, a physicist at Mahatma Gandhi University, speculated, in *Astrophysics and Space Science,* that unidentifiable red cells from two months of rain in Kerala, India, in 2001 may be alien microbes. The tiny reddish cells (10 microns across) lack DNA; yet, they can reproduce, even in water superheated to 600°F—more than twice the temperature any earthly life form can survive. Are these alien bacteria that evolved on some high-temperature planet or adapted to brutal conditions in space?

Over 40 tons of cosmic dust drops onto the Earth's surface every day. How much of it contains living alien matter, or its building blocks? Exobiologists see evidence that this might be the case. Professor Milton Wainwright of England's University of Sheffield stated on March 26, 2006, "These are living bacteria. . . . We think there are large quantities impinging on the Earth all the time."

16. MAYBE WE SCARED THEM OFF. Scientists first tried to describe humans to aliens in 1972, when Carl Sagan and Frank Drake designed a plaque with a naked man and woman for the *Pioneer 10* spacecraft.

This leads to more speculation. How would we recognize (to take nudity one step farther) alien pornography? What is the psychology of creatures who, for all we know, may come from an evolution that had developed, say, 7 sexes, or 35?

17. DON'T MISS THE SOUNDTRACK. The two *Voyager* probes launched in 1977 included a 12-inch gold-plated record carrying whale calls, greetings in 55 human languages, and a Bulgarian folk song.

Yes, by all means let's confuse other inhabitants of the universe.

Alien ears might well interpret all 55 different human languages as one very complicated language. Or as meaningless background noise. Parallel: only a wolf expert could distinguish one pack's howl from another.

If we can't communicate intelligently with creatures from our own world—including dolphins, with an IQ comparable to ours—how can we expect any linguistic logic in common with beings from a totally alien evolution, who may be dozens, hundreds, or even millions of times smarter (or stupider) than we are?

18. JUST IN CASE . . . NASA even included a phonograph stylus and playing instructions.

Why a folk song from Bulgaria, rather than some country more widely representative of Earth culture? According to the online *CIA Factbook*, Bulgaria is "slightly larger than Tennessee," with an estimated population of 7,322,858. Why not folk songs, then, of Tennessee (population over 6,000,000)? Nashville's music is much more dominant on Earth than Bulgarian milkmaid chants.

If the choice was random, then why not a folk song from the country that follows alphabetically in the *Factbook*—Burkina Faso? It's "slightly larger than Colorado," although we guess that few of its inhabitants are experienced skiers.

19. AND IT'S COMMERCIAL-FREE. On September 30, 2006, the French Centre for National Space Studies beamed *Cosmic Connexion*, a TV program at a sun-like star called Errai, 45 light-years from Earth. It should reach Errai in 2051.

Whenever and wherever our broadcasts arrive, alien anthropologists studying Earth culture will probably learn as much about us from our commercials as from our programming.

Human interaction involves commerce. We are what we buy, from soap suds to ideas. Making, selling, choosing, and advertising reveal our psychology. Archaeologists seek clues about ancient civilizations by studying shards of pottery and crumbling papyri. Alien social scientists are likely to look for keys to our civilization in what we hype, reasonably inferring that we wouldn't bother broadcasting anything we didn't consider important.

Since it will be hard for them (as it is increasingly for us) to distinguish news from fiction, or commercials from social commentary, they may conclude that earthlings (especially in Western Earth) fear bad breath, body odor, constipation, baldness, obesity, and erectile dysfunction but love and respect bargain prices, people who yell and scuffle before live audiences, and banal men who try to seduce banal women in crude courtship rituals.

Would they be more right than wrong?

20. MAYBE WE'RE THE ALIENS. Maybe we are the aliens—or at least their offspring. Some theorists believe that space itself, not just the planets, is teeming with life. Supporters of "panspermia" offer the image of intergalactic life blowing

like a wind across the universe, seeding planets with material to use in their particular evolutions.

This could be one answer to Fermi's Paradox. Enrico Fermi (1901–1954), a Nobel Prize–winning Italian physicist, was subjected to a lengthy harangue about the certainty of intelligent life among the hundreds of billions of star systems. It was impossible, said a colleague, to believe that we are not regularly visited by technologically advanced beings. Fermi shrugged and quietly asked, "So, where is everybody?"

Short form answer: We're right over here, Enrico.

We have met the enemy, and they are us.

—*WALT KELLY,* Pogo

* * *

IS THERE ANYBODY OUT THERE?

There are three main interpretations of alien reasons to visit: neutral, heartwarmingly optimistic, and pretty scary:

- Simple Scientific Curiosity. They are explorers like us, only more advanced. They may be following up on some sociobiological experiment begun millions of years ago.
- Benevolence. They are wise elder brothers here to help us. Aw, shucks. This is the Yoda Syndrome; "The Day the Earth Stood Still" theory. They came to save us from ourselves. Or, as in *Forbidden Planet,* to teach us the dangers of "monsters from the Id" and of overly ogling Anne Francis's lovely legs.
- Malevolence. They are monsters here to destroy us and take our planet. At very best, not our pals. This jaundiced

view is evidenced in works like *War of the Worlds, Independence Day,* and an endless series of sensationalist books, stories, films, and semi-scholarly warnings. Alarmists remind us that history records virtually no examples of advanced civilizations coming to less advanced civilizations without destroying them or at least exploiting them.

There are thinkers who suggest that aliens are as likely to emerge from Earth's nanotechnology labs as from outer space. Experiments with recombinant DNA and other biological tinkering could result in previously unseen life forms.

Humanity has the stars in its future, and that future is too important to be lost under the burden of juvenile folly and ignorant superstition.

—ISAAC ASIMOV, U.S. scientist

20 THINGS YOU DIDN'T KNOW ABOUT ANCIENT WEAPONS

Never give a sword to a man who can't dance.

—CONFUCIUS, Chinese philosopher

Humankind is unique in several ways that distinguish us from the rest of the animal kingdom. We are toolmakers. We invented language. We are aware of our own mortality. We can imagine a deity, a future, sublime artistic and intellectual abstractions. But we are also a very violent bunch. Ever since we learned to gather into groups, we have fought other groups. Sometimes, like animals, it has been to protect our young or to claim our share of limited resources. Sometimes a group has fought to protect its territory—which, of course, implies that another group was fighting to take that territory.

But face it—we simply seem to like a good dust-up. Humans are takers of things and makers of war. So what could be more natural than for us also to be makers of weapons?

Throughout history we have been truly inventive in finding ways to hurt one another. Our artifacts include an almost endless series of implements designed to hit, crush, rip, mangle, burn, dismember, slice, poke, spread illness, and otherwise cause misery, harm, and death.

Here are just a few lowlights in the history of human cruelty—and they do not even include tools designed only for torture.

* * *

1. EVER HEARD OF THE ATLATL? No, not a misspelling. Even earlier than the bow and arrow, the atlatl was an aggressive "force multiplier" like the rock and sling David used to whack Goliath. (The word is from the Aztec Nahuatl, who also had the weapon.) The atlatl was used in many ancient societies, in one version or another, for hunting or for warfare.

The atlatl was a stick with a grip at one end and some kind of cup or holding slot at the other, into which the butt of a spear, dart, or arrow could be placed. The idea: generate speed and force into the projectile. Just as a bowstring releases stored linear energy to shoot arrows, the atlatl intensifies angular energy from the user's arm. A skilled atlatlist could lurch forward and fire his missile with whip-like action, often accurately for distances close to 100 meters.

2. DIRTY FIGHTING. Ancient armies used bacteriological warfare centuries before anyone knew about bacteria. But warriors had practical experience poisoning water supplies with excreta, fungus, and various other rotting gack, which weakened enemies with diarrhea and other sickness. Plagues referred to in the Bible may in fact have been microbe attacks.

The Fifth Plague (Exodus 9:1–7) was a livestock-specific disease—probably the earliest reference to anthrax—or possibly Rift Valley fever, a viral affliction that also affects humans, spread by infected mosquitoes from Jordan to Mozambique.

Biological warfare has been recorded as far back as 400 B.C., when Scythian archers reportedly dipped their arrowheads into decomposing bodies, or manure mixed with the blood of fallen soldiers or animals.

In Assyria, c. sixth century B.C., fighters poisoned their enemies' drinking water with spoiled grain and fungus that caused hallucinations and digestive problems for whoever drank it. Likewise, Romans dumped decaying human or animal remains into the water sources of besieged cities, or catapulted them over the walls.

Literature from 300 B.C. on cites Persians, Greeks, and Romans dropping dead animals into enemies' wells to contaminate them. At the Battle of Eurymedon in 190 B.C., the Carthaginian general Hannibal defeated King Pergamon in a sea battle by lobbing earthen jugs filled with poisonous snakes onto the enemy ships.

3. SPEARS, JAVELINS, BOWS. Ancient Greek infantrymen ("hoplites") armed themselves just before battle because their equipment was heavy—at least 50 pounds. Since theirs was a citizens' army, each man armed himself with the weapons he could afford and knew how to use. There were no uniforms, which led to many injuries and death by friendly slash.

A hoplite typically went into battle in formation, wearing both breastplate and helmet and carrying light shields to protect his left side, depending on the man next to him to protect his right. Since hoplites were an unpaid militia, military campaigns were short, usually waged in summer so warriors could return home for the harvest. Battles were

fairly formal winner-take-all affairs, often lasting only an hour or so.

No weapon has ever settled a moral problem. It can impose a solution but it cannot guarantee it to be a just one.

—ERNEST HEMINGWAY, U.S. writer

Classical Greek warfare was straight-ahead fighting, unlike today's preference for stealth or covert guerrilla actions. Fighters faced each other, army to army, in broad daylight, usually on a plain. At a signal they would charge ahead and smash into each other, each side hoping to break through and encircle the other army. When the soldiers on one side saw they were losing, they usually fled, and were only rarely pursued.

History suggests that casualties were fairly slight compared with battles in modern times with our weapons of mass (and plural) destruction. Greek units rarely suffered more than about 5% casualties—and those were the losers. On the other hand, most of the dead tended to be community leaders, since the ancient Greeks believed (unlike generals and politicians today) that leaders should lead their troops and not just send them into battle. Often a war was decided by a single victory in the field and topped off by lots of booty collected for ransomed prisoners.

4. SIZZLE, SIZZLE. Greek fire, an ancestor of both flamethrowers and napalm, was devastating in early naval battles, since it not only burned ships but continued to burn on water itself! Its precise formula remains unknown—perhaps it was some form of naphtha or other hydrocarbon. There are records of its use in the seventh century, but it was probably developed earlier by Alexandrian chemists.

This lethal blazing liquid was pumped through a tube, with results so devastating that the mere whipping out of a tube could make enemy ships turn sail and flee. (Just as today, a death's-head sign with the words "Caution—Minefield" will usually discourage incursion.)

The Byzantines held the monopoly on Greek fire. Only they knew the exact formula, which they protected as fiercely as Coca-Cola protects theirs. When that formula was lost, or somehow forgotten, after the failed second Arab siege of Constantinople in 717/718 AD, the Byzantines' greatest military advantage evaporated, and the Muslims eventually conquered their territory.

5. MULTI-TUSKING. Elephants were a thundering weapon in India 3,000 years ago. Persian pachyderm charges had a deterrent effect on Alexander, whose troops faced 15 of the beasts at the Battle of Gaugamela in 331 B.C. Alexander won the battle (although his pet greyhound was crushed to death under a huge hoof), but he decided against pursuing his invasion. Later he defeated a Punjabi general despite a 200-elephant attack. Some Eastern kingdoms were said to have tens of thousands of trained war elephants—which may explain why Greek is not the language of China, India, or Iran.

Precursors of tank warfare, armored war elephants were used mainly to thwart and scatter chariot charges and to trample infantry. They were not frequently deployed, but they were generally effective in an attack—even as a psychological warfare measure.

Historians write of Hannibal's daring, unexpected march across the Alps to invade Rome, with his "secret weapon," a phalanx of 37 elephants from Carthage. What is less known is that of the 40,000 troops that began the two-week trek, as many as half died of the cold, avalanches, or disease before reaching the Italian border.

6. LASER WARFARE IN 212 B.C.? One ingenious weapon attributed to Archimedes during the siege of Syracuse is the "burning mirror." Any little sadist who ever incinerated ants under a magnifying glass knows the principle. The legend: large mirrors concentrated sunlight on an attacking fleet, reducing ships to ashes. Although theoretically possible, the story is unlikely.

The "burning mirror"—whether used at Syracuse or not—makes scientific sense. An array of mirrors collecting the sun's rays from different angles can in fact create an intense beam of energy, which when focused on a single wooden ship can cause sails and deck to burst into flame, and presumably sear the flesh of any unfortunate sailors hit by the beam.

Such a device was also reported to have been used in the defense of Constantinople as late as 514 AD. Lasers, ray guns, and phasers were still far in the future, but the "burning mirror" is clearly their ancestor.

Archimedes (287–212 B.C.) was a Greek mathematician and inventor born in Syracuse on the island of Sicily, then part of the Greek empire. He studied at Alexandria, the world's center of wisdom and scientific learning, and was known for shrieking "Eureka!" and running

towel-less through the streets after discovering the law of buoyancy while bathing. Most of his written work died with him, as he scorned practical applications of science. Still, he did everything he could to save his home city from Roman attack, and he died defending Syracuse at age 75.

7. BARBECUE WARFARE. PETA will really hate this one. Blazing animals—monkeys, pigs, and dogs—were reportedly used as living weapons (very briefly living). Still, the Chinese are said to have deployed incendiary monkeys against enemy ranks, while the Macedonians supposedly released herds of flaming pigs shrieking toward Persian elephant troops, causing the pachyderms to panic and stomp backward, crushing or scattering their own army.

The most powerful weapon on earth is the human soul on fire.

—*FERDINAND FOCH,*
French military commander

8. BE INSCRUTABLE. Sun Tzu saw human intelligence as the ultimate weapon. "What enables [wise leaders] to conquer . . . and achieve extraordinary success is foreknowledge. For local spies, use the enemy's people. For internal spies use the enemy's officials. For double spies use the enemy's spies. For dead spies use agents to spread disinformation. [Those] who are able to obtain intelligent agents . . . are certain for great achievements." Is Sun Tzu read inside the Beltway?

There is no instance of a country having benefited from prolonged warfare.

—*SUN TZU, military strategist*

Sneakiness does work. Subterfuge is an ancient war weapon. At the siege of Troy, Odysseus was inspired by Athena (goddess of wisdom—and military intelligence?) to build that huge wooden horse to conceal 30 (some say 10) warriors in full armor. (Was there a built-in latrine?) The plan's brilliance: the fleet sailed, presumably lifting the siege. Only one sailor stayed ashore, feigning rage that the Greeks had abandoned him. He assured the Trojans that the horse would bring them luck. He did not stipulate good luck.

All war is based on deception.

—*SUN TZU, military strategist*

9. NOTHING NEW UNDER THE SUN. Our term "ballistic" comes from the Roman "ballista," a torsion-energy catapult that could propel rocks or other weapons (including pots of human waste or deadly scorpions) thousands of yards over enemy walls. The Greeks—those brilliant philosophers and humanists—were not above coating arrowheads with poison, jellyfish stingers, or allergenic plant sap.

The Romans owed the conquest of the world to no other cause than continual military training, exact observance of discipline in their camps, and unwearied cultivation of the other arts of war.

—*FLAVIUS RENATUS VEGETIUS,*
Roman military theorist

10. REACH OUT AND STAB SOMEONE. Once early man learned to stab, he realized it was safer to stab from farther away than the other guy. Spears developed into longer spears . . . later into battle pikes. Early historical records note organized pike tactics at the time of Philip II of Macedonia (father of Alexander the Great), whose "sarissas" could be up to 20 feet long. Not a good choice as a concealed weapon.

Leadership is intangible, and therefore no weapon ever designed can replace it.

—OMAR N. BRADLEY, U.S. general

11. CHARIOTS OF TYRE. War chariots were used in the ancient Middle East around 2000 B.C. to suppress rebellions in far-flung territories. Since most of that region is flat, chariots delivered the best "rapid deployment force" then available. Until horses could be bred that were hardy enough for desert travel, chariots were pulled by donkeys or oxen.

Every attack has a defense. Since chariots work well only on flat terrain, defenders preferred to make their stand on rocky or hilly terrain. Chariots usually attacked as a widely spaced front, not in single file or in twos or threes. This afforded maximum flexibility for sweeping movements and varied attack angles once they got through enemy lines.

The best defense against such a frontal assault was to counterattack from the flanks, forcing the chariots into close bunches. When defending infantry charged, it was most effective to use spears and arrows against the enemy horse or driver, not the archer. A driverless, disabled chariot is no longer a war machine; it's a souvenir.

12. SHUT UP AND SHOOT. Most early Middle Eastern war chariots carried two men—driver and archer. Of light construction, the chariots could be floated across rivers. Eventually, larger transport chariots—early ancestors of the APC (armored personnel carrier)—were built to carry some half dozen warriors.

But were chariots weapons or vehicles? A bit of both. Clearly, they were conveyances, since they carried men into battle (usually archers). But analysts also point out that the Hittites and others used chariots not only as an attack platform for delivering arrows but also to smash into enemy troops. Like modern tanks, Hittite chariots were supported by ground troops, who protected personnel from disabled chariots. Egyptian chariots were more often used just to support the archers who rode in them.

Recent archaeological evidence suggests that the first animal-drawn chariots may have emerged on the Eurasian steppes. Burial sites along the Russia–Kazakhstan border were found to contain horse remains buried alongside chariots. Carbon dating indicates that they belong to what archaeologists call the Middle Bronze period—at least two centuries before the earliest evidence of Middle Eastern chariots.

13. SOCIAL SLASHING. Besides their traditional razor-sharp war swords, Japanese samurai carried ceremonial fans called tessen. These apparently social items concealed honed metal ribbing, which enabled the fan to serve also as a lethal gouging or slashing weapon. So be careful next time you're tempted to tease Karl Lagerfeld for fanning himself in public; he may be a closet samurai.

The sword was a very elegant weapon in the days of the samurai. You had honor and chivalry much like the knights, and yet it was a gruesome and horrific weapon.

—*DUSTIN DIAMOND, U.S. actor*

14. A LESSON FROM GENERAL PORCUPINE. Foot soldiers with long pikes would anchor them in rows of varying angles to frustrate both cavalry and infantry charges. Also called the hedgehog, this formation was an effective 360-degree defensive wall against attacks from any direction.

Rome's military reputation rests more on discipline than on its technology, which was not significantly more developed than that of the Carthaginians, Persians, or Greeks. One example of battle discipline was the "turtle" formation (testudo). Infantry would close ranks tightly, surrounding the entire company with a wall of shields. Men in the front were covered up from nose to shins for the maximum combination of visibility and protection. Men in the middle ranks balanced their shields on their helmets and overlapped them to protect themselves from flying arrows or rocks. Soldiers on the sides and rear faced outward with shields covering the other angles, making a living fortress.

There is only one sort of discipline, perfect discipline.

—*GEORGE S. PATTON,*
U.S. general

It is one thing to praise discipline, and another to submit to it.

—*MIGUEL DE CERVANTES,*
Spanish novelist

15. BETTER THAN BOWIE. The famous Roman gladius, preferred weapon of the legions, was 18 inches long, 2 inches wide, and narrowed at the center. It had a form-fitting bone handle shaped for the hand with a bulbous ball at the end to help balance the weapon. It was designed not for slashing but for stabbing. Roman soldiers were trained to deploy the gladius horizontally to thrust lethally between ribs.

Roman shields were semi-cylindrical, reaching from chin to knees, and light enough to be carried comfortably on long marches. They were made from layers of wood glued together (not unlike plywood); each layer was at an angle to the previous one for increased strength. The shields were edged in light sheet bronze with heavier bronze in the center. Presumably there was a handgrip or strap to enhance maneuverability in battle.

The Romans did not allow anyone to escape to fight another day. They were ruthless in battle, and they believed in total victory by destroying the enemy's fighting power completely—even to the extent of wiping out innocent civilians and wounded enemies.

Few men are born brave. Many become so through training and force of discipline.

—FLAVIUS RENATUS VEGETIUS,
Roman military theorist

16. M*A*S*H IN PREHISTORY. Ancient weapons produced ancient wounds: crushed bones, ripped flesh, horrifying punctures. To fight infection (recognized but not understood as of bacterial origin), Greek battlefield physicians applied copper-based powders or a combination of honey and red copper oxide. Sometimes this treatment worked, according

to archaeological evidence of warriors who recovered from multiple serious wounds.

Millennia before doctors knew of microbial infection, they treated battlefield wounds with a range of specifics with what we would call antibiotic properties: wine, honey, fresh animal grease and skins, gauze-like dressings. They occasionally applied maggots to eat away necrotic tissue from open wounds. Modern physicians agree that some wounds heal more quickly if kept moist than if allowed to scab over. They are divided on the use of maggots, leeches, and eye of newt.

17. READY TO HURL. Siege engines are big machines designed to propel projectiles against walls to smash them or lob aggressive stuff over them. The trebuchet and the better-known catapult were technologically advanced versions of the ancient sling, using power stored either in a counterweight (trebuchet) or in wound-up ropes (catapult)—power suddenly released to heave something deadly. In either case, destruction and mayhem were the goal.

Trebuchets were made of wood. The counterweight version was used by twelfth-century Christian and Muslim armies to fire heavy projectiles against enemy strongholds.

Catapults and trebuchets were rarely brought along with the army because they were cumbersome. Soldiers would carry only the essential moving parts, assembling the rest upon arrival at the siege location, since there was usually plenty of timber nearby to build the superstructure. Roman catapults were usually fired from about half a mile from the target.

18. USE WHAT YOU'VE GOT. Ancient Egyptian warships were built from marsh reeds woven together and waterproofed

with pitch, and powered by one square sail. No wind? No problem, thanks to 10 to 20 grunting oarsmen on each side, plus steering paddles. Onboard marines fired arrows or spears at enemy sailors and used a ramming spike mounted low on the prow to sink approaching boats.

One ingenious oddball naval defense was the Archimedes claw, used during the siege of Syracuse (212 B.C.). An anti-ship weapon made of long poles that swung above approaching Roman ships, it dropped leaden weights or iron hooks through them, lifted them part way out of the water, and dropped them sideways or stern downward, back into the sea.

19. RETURN TO SENDER. Since prehistory, people have hurled things at animals or at one another, depending on whether they were hungry or angry. But indigenous Australians did not consider boomerangs weapons, but toys. When hunters or warriors mean business, they throw sticks or clubs not in a swooping arc but in a straight shot designed to whack their target.

20. GIDDYUP. HEEYAH. KILL. People have ridden horses for millennia. But not until the saddle and the stirrup was effective cavalry possible. Stirrups are a great force multiplier. They give riders greater striking power and let them lean from side to side to deliver or avoid blows. Mongols and other Central Asians brought the stirrup to the West, where they are currently used in upscale equestrian shows in tony suburbs, in which nobody gets mangled.

There are only two forces in the world, the sword and the spirit. In the long run the sword will always be conquered by the spirit.

—NAPOLEON BONAPARTE,
French emperor

* * *

THE FUTURE OF WEAPONRY

Human civilization—or at least human groups—have made great strides in toolmaking since our dim beginnings. Indeed, that may be the area in which we have made the most dramatic advances, in many cases to the detriment of the other areas (language, things of the spirit) in which we supposedly exceed the capabilities of the other earthly animals. There can be little doubt that our zeal for making tools of war and mastering their use is the outstanding characteristic of our species. Modern day catapults—guided missiles and "smart bombs"—can obliterate entire cities half a planet away in seconds; no more need to wait patiently to starve populations (although some national policies seem designed to do that as well).

We will continue to make things that kill, despite the evidence that terror and murder can be only temporary satisfactions, never permanent solutions. Perhaps some day we will wake up and actually start to learn from history.

Our scientific power has outrun our spiritual power. We have guided missiles and misguided men.

—MARTIN LUTHER KING, JR.,
U.S. civil rights leader

20 THINGS YOU DIDN'T KNOW ABOUT BEES

We're all busy little bees, full of stings, making honey day and night, aren't we honey?

—*BETTE DAVIS, U.S. actress, as Margo Channing in* All About Eve

So often it's the little things that count—little everyday things we don't notice until their value is pointed out to us, or until they're suddenly needed but not available. Water, for instance; a nail for a loose horseshoe or plank; salt.

Bees.

Bees? Yes, for thousands of years of civilization—and millions of years before that—bees have been an important link in the food chain. Busily pollinating, cross-pollinating, and providing wax, therapeutic products, balance within the insect kingdom, food. Did we say food? Indeed.

The human diet consists not only of meats, grains, fruits and vegetables, dairy products, and seafood. We also enjoy a delicious, versatile sky food—honey from bees. (We can deal with locusts elsewhere.)

The ancients appreciated the bee, and today we are discovering new possibilities provided by busy buzzers, which we rarely notice except when we accidentally step on one, when they annoy

us at picnics, or delight us in those sweetly sad summery scenes in *Elvira Madigan*.

A bee is never as busy as it seems; it's just that it can't buzz any slower.

—*KIN HUBBARD,*
U.S. humorist

* * *

1. BEE FRUITFUL. There are at least 16,000 classified species of bees. Most are solitary insects; only about 5% are social, the most common being the honeybee. As many as 80,000 of them colonize a single hive.

Bees fly on every continent but Antarctica, and since ancient times they have been used as a source of food. They feed on nectar and pollen (unlike mosquitoes, whose female feeds on blood—see the chapter on mosquitoes).

If you want to gather honey, don't kick over the beehive.

—*DALE CARNEGIE,*
U.S. self-improvement impresario

2. ALL THE QUEEN'S MEN. Drones—male honeybees—do no work whatsoever. They live only for mating with the queen. Hey, it's a gig. But when there is a shortage of food in the hive, the workers kick the drones' lazy gigolo asses out.

Hatched from unfertilized eggs, drones are the biggest hunks in the hive, flourishing from late spring to summer. They have big heads, big bodies, no stinger. Because of their size, drones eat three times as well as workers—not unlike our own idle rich. So when cold weather comes or

food supplies dwindle, the workers force the drones outside to starve. Workers of the hive, unite!

If you want creative workers, give them enough time to play.

—JOHN CLEESE, British actor

Even sleepers are workers and collaborators on what goes on in the universe.

—HERACLITUS, Greek philosopher

3. WHAT HAPPENS IN MID-AIR STAYS IN MID-AIR. Drones' huge eyes (twice as big as the eyes of worker bees) make it easier to track Her Majesty during the mating flight. When they connect, it's very clumsy, even by human mating standards. Picture an Airborne Warning and Control System refueling in mid-air.

Drones don't usually mate with a virgin queen from their own hive. Entomologists are unsure how mating areas are selected, but the virgin queen tends to mate some distance from her home hive, and she will be inseminated by several drones during the mating flight.

Caution: men may find the next sentence disturbing. Mating invariably kills the drone, since his entire phallic area is torn from his body to remain inside the queen. Talk about rough sex.

I had a patient once who dreamed she kept her husband in the deep freeze except for mating. Lots of men feel that way.

—ROBERT JOHNSON, U.S. musician

All nature's creatures join to express nature's purpose. Somewhere in their mounting and mating, rutting and butting is the very secret of nature itself.

—GRAHAM SWIFT, British author

4. THAT HUSSY. The queen continues to mate until she collects more than 70 million sperm from multiple males—all suddenly dying or dead. Apparently drones are slow learners, or they don't share information very well.

It is not clear that intelligence has any long-term survival value.

—STEPHEN HAWKING, British physicist

The queen's copulation cruise lasts 1 to 2 days, during which time she is typically adored by 7 to 17 drones. Their collective sperm is enough to last the rest of her reproductive lifetime—3 to 4 years—laying anywhere from 600 to 1,500 eggs a day. That's a lot of baby bees.

Learning is not compulsory . . . neither is survival.

—W. EDWARDS DEMING, U.S. scientist

5. OOPS. The queen was known as the king until the late 1660s, when Dutch scientist Jan Swammerdam dissected the hive's biggest bee and discovered ovaries.

I do not want a husband who honours me as a queen, if he does not love me as a woman.

—ELIZABETH I, queen of England

This Amsterdam-born naturalist took his medical degree at the University of Leiden, then made major discoveries in anatomy: lymph vessel valves, respiratory physiology, nerve-muscle function. He also discovered and described the mechanism of penile erection. Essential.

His classification of insects—still used—was based on their modes of development. He proved that insects do not generate spontaneously, as was then thought, but come from eggs laid by females of the same species. Sure, it's obvious today. But back then, Swammerdam's discovery was revolutionary.

In 1670 he began to dissect insects under a microscope. This led to his identifying bee ovaries—which meant that His Majesty should henceforth be Her Majesty. His writings reveal a profoundly religious bent. In 1675 he abandoned science for mysticism (and major hypochondria). His final anatomical writings are larded with religious poems and philosophical musings. He died of the long-term effects of malaria (not spread by bees) before completing his "greatest work."

Religion is to mysticism what popularization is to science.

—HENRI BERGSON, French philosopher

6. WE DON'T ALL LOOK ALIKE TO THEM. Australian researchers have discovered that honeybees can distinguish human faces. The insects were shown black-and-white photos and given treats whenever they recognized their subject.

As reported in the *Journal of Experimental Biology* on December 15, 2005, honeybees were shown standard pictures used in human recognition tests. Testers put drops of sugar water on one and bitter liquid on the others. The bees soon learned to land on the "sweet" face. Interestingly, they also

retained memory of that face, flying directly there with great accuracy (80%) for days after their initial experience. They even recognized faces that were quite similar, regardless of where the pictures were located. But, like humans, they performed less well when photos were upside down.

Bees' "knowledge" of faces is simply pattern recognition, which they use to locate nectar sources. Bees' eyes, like those of other flying insects, are compound eyes of many facets, aided by three "simple" eyes. Capable of seeing ultraviolet light, which is invisible to humans, bees can find their way to a target whose pattern they recognize, probably by "strobing" as they fly past.

There's no evidence that bees realize they're seeing a human. To them we're just another pretty pattern in life's smorgasbord of flowers. That said, bees identify human faces more accurately than some humans can—with 1/10,oooth the number of brain cells. Perhaps we don't get enough sugar water rewards in our diets. This bee research may be helpful in developing face-recognition software for security cameras.

I never forget a face, but in your case I'll be glad to make an exception.

—GROUCHO MARX, *U.S. comedian*

7. AIR SUPPORT FOR SNIFFER DOGS. Homeland Security, take heart. In the Stealthy Insect Sensor Project, Los Alamos scientists have trained bees to recognize explosives.

R&D scientists at the Los Alamos National Laboratory in New Mexico are training bees to sniff out explosives like those carried by potential terrorists. The bees are conditioned to stick out their proboscis—the long snout used to suck up

nectar—whenever they smell explosives. As in most animal training programs, the research is reward-based. Bees get sweet treats whenever they identify even microscopic traces of dynamite, C-4, or other explosives like those used for improvised explosive devices (IEDs).

The detective bees would presumably be delivered to checkpoints in small hand-held detectors, and deployed by trained handlers as needed.

There is nothing more dangerous than security.

—SIR FRANCIS WALSINGHAM,
British statesman

8. ANOTHER CUPPA MEAD, M'DEAR? The term "honeymoon" supposedly comes from a northern European custom in which newlyweds would—for a month ("moon")—drink a daily or perhaps nightly cup of mead, the hearty intoxicant made from fermented honey. But there's another less cutesy version.

According to the website *hudsonvalleyweddings.com*, the tradition of a post-wedding "honeymoon" is very different from today's sweetness-and-light interpretation.

They point to origins in the Old Norse word Hjunotts-manathr—abduction of a bride from another tribe. The wife-swiper then played Hide the Bride, friends helping keep the connubial location secret, lest horned brothers track and whack the horny abductor. Some of this was clearly a game; after the bride's kinfolk "abandoned the search" (probably a "moon" later), the couple returned openly to the groom's village.

The tradition of kidnapping a girl and plying her with honeyed wine (to lessen the burden of sudden wifehood?)

dates back to Attila the Hun in the fifth century. (Attila died of a nosebleed while seriously drunk—probably not on honeyed wine—during his wedding night.)

Bride: A woman with a fine prospect of happiness behind her.

—AMBROSE BIERCE, U.S. journalist

Go to a place where you're not going to be stressed, because a honeymoon itself can be a stressful thing.

—DIANE VON FURSTENBERG, Belgian designer

9. GREAT MOMENTS IN INSECT SLANG. The term "bee's knees" was coined by American cartoonist Tad Dorgan, who was also responsible for "the cat's pajamas," "the flea's eyebrows," "the canary's tusks," and "Yes, we have no bananas."

Every age hath its expressions, and the 1920s were no exception. "Bee's knees," suggesting the dernier cri or something really cool and groovy, started around 1924. Some suggest that it may be a comical mispronunciation of "business."

The downtrodden . . . are the great creators of slang.

—ANTHONY BURGESS, British novelist

All slang is metaphor, and all metaphor is poetry.

—G. K. CHESTERTON, British writer

10. LICK THAT WOUND FOR YOU, SOLDIER? In ancient times, and as recently as World War I, honey was used to treat bat-

tlefield wounds because it attracts and absorbs moisture, making it a valuable healing agent.

Ancient medical records show that Egyptian doctors used honey as an active ingredient in many medicines. Greeks and Romans also spread honey on open wounds to quicken healing. An organic substance with no caustic properties, honey contains vitamin and mineral elements that fight bacterial infection. Bacteria don't seem to develop resistance to honey as they do to modern-day antibiotics! This may be due to a natural antibiotic agent produced in the bee's system, which prevents honey from growing mold spores.

Plastic surgeons are known to use honey to speed the repair of post-operative scar tissue and to treat varicose ulcers.

It is reasonable to expect the doctor to recognize that science may not have all the answers to problems of health and healing.

—NORMAN COUSINS, U.S. editor

The art of healing comes from nature, not from the physician. Therefore the physician must start from nature, with an open mind.

—PARACELSUS, Swiss physician

Score another one for Mother Nature. There is growing evidence that honey may be effective in treating certain "superbugs"—bacteria such as the dreaded MSRA that have become resistant to powerful antibiotics and claim thousands of lives worldwide each year. (See chapter on germs.) Researchers at the University of Wales in Cardiff discovered in 2007 that honey attacks super-staph even when the honey is diluted, inhibiting infection. Another experiment on 20 patients in Liverpool found that a New Zealand honey was equally

effective treating their wounds, which were infected with drug-resistant microbes.

11. ETERNAL SHELF LIFE. Honey never spoils. Edible honey has been found in pharaohs' tombs and in other archaeological sites.

Archaeologists probing the Turkish seacoast in 2003 for evidence of a Noah-like flood unearthed planks from a sunken ship about 300 feet under water. The deck remnants were coated with a form of wax, perhaps even beeswax. According to maritime specialist Cheryl Ward of Florida State University, this may indicate that the ship was transporting honey. The research vessel *Hercules* retrieved six amphoras (ceramic containers), which are being analyzed for pollen. If test results prove positive, that would suggest a robust trans-Mediterranean honey trade.

To the present writer a careful study of the facts now available seems to leave no doubt that civilization was born at the southeast corner of the Mediterranean.

—JAMES H. BREASTED, U.S. historian

People had already settled the islands in the Mediterranean and around Great Britain long before the first pharaoh built the pyramids in Egypt.

—THOR HEYERDAHL,
Norwegian explorer

And bees were part of it all.

12. BUZZING CLOCKS. Bumblebees can estimate time intervals. Researchers have found that the insects extend their tongues in synch with the rhythm of a sweet reward. This aids in the hunt for nectar, whose availability waxes and wanes.

For years, scientists insisted that only sophisticated animals with highly developed neural systems could perceive time intervals shorter than daily rhythms. But now, entomologists from the University of Western Ontario have discovered that bumblebees, once introduced to a short feeding cycle and rewarded by following it, adjust sufficiently to estimate when the reward is coming. Proof? They extend their probiscis as the newly conditioned feeding time approaches.

13. HIYA, OLD TIMER. *Melittosphex burmensis,* recently found in amber in a mine in northern Myanmar, is the oldest bee known. It lived 100 million years ago.

It's a bee, it's a wasp, it's a bee, it's a wasp—it's a bit of both, say experts from Cornell and Oregon State. The wee bee (0.12 inch) is a male with characteristics of both insects, most wasps being carnivores, and bees kind of vegan. It may be a missing link between the two species, and for that reason alone it deserves further study. Here's why: only females pollinate flowers. The search continues for a lady *Melittosphex b.*

The earth laughs in flowers . . .

—RALPH WALDO EMERSON,
U.S. writer

14. SHOULDA QUIT WHILE HE WAS AHEAD. After pioneering the laws of genetics with pea plants, Austrian monk Gregor

Mendel (1822–1884) bred a strain of hybrid honeybees. Unfortunately, they were so vicious he had to kill them.

Few took notice when Mendel's paper appeared in 1866. I mean, garden peas having family trees? And since when do monks know more than "real" scientists? Two years after publication, while the scientific world was catching up with his breakthrough, Mendel was elected abbot of his monastery. He left peas behind, devoting the rest of his life to monastic duties—and a side-trip into apiculture. He developed a strain of honeybees whose honey was exceptionally tasty. But their aggressive stinging was too much for the neighbors, so he destroyed the entire species.

My grandfather always said that living is like licking honey off a thorn.

—LOUIS ADAMIC, U.S. writer

15. NO, THEY'RE NOT HUMMING. The buzz you hear when a bee approaches is the sound of its four wings moving at 11,400 strokes per minute. Bees fly an average of 15 mph.

Aerodynamically, the bumblebee shouldn't be able to fly, but the bumblebee doesn't know it so it goes on flying anyway.

—MARY KAY ASH,
U.S. cosmetics marketer

Beekeeping is a surprisingly widespread enthusiasm, spanning centuries and personality types. A few notables with "bees in their bonnet" are these:

Alexander the Great; Aristotle; Augustus Caesar; Benjamin Franklin; Brigham Young (Utah is the "Beehive State"); cavemen (first images of bees in Spanish cave paintings, c. 7000 B.C.); Democritus; Gregor Mendel; Henry Fonda (gave friends jars of Henry's Honey, and as a boy earned an Eagle Scout badge for beekeeping); Hippocrates; Jonathan Swift; Karl von Frisch (Nobel Prize–winning entomologist); Leo Tolstoy; Robert S.S. Baden-Powell (founder of Boy Scouts); Marcus Aurelius; Maria von Trapp (loved the sound of bees' music on her Vermont farm); Martha Stewart; Maurice Maeterlinck; Muhammad, the Prophet of Islam ("Honey is the remedy for every illness"); Muhammad Ali ("Float like a butterfly, sting like a bee"); Napoleon Bonaparte; Pope Urban III; Pythagoras; Ramses III; Raymond Poincare; Shakespeare; Sherlock Holmes; Sir Edmund Hillary; Thomas Jefferson; Vicente Fox (ex-president of Mexico); Viktor Yushchenko (president of the Ukraine); and Virgil.

16. FEELING THREATENED? Newly hatched queens immediately kill all other hatched and unhatched queens in the hive.

Law of the Hive: there's room for just one queen. Sometimes it comes down to a battle to the death. Queens, predictably, do not feed themselves. They preen and devote themselves to reproductive duties. She's bigger than workers, longer than drones; her slender waspish body is adorned with sparkling gold hairs. (For you language buffs, the Persian word for bee is *zanbur*—"blonde woman.")

17. THE HONEYBEE BOOGIE. In 1943, Austrian zoologist Karl von Frisch published his study on the dances bees perform to

alert fellow workers. A round dance indicates that good is close by; a waggle dance means it is distant.

Dancing is a sweat job.

—FRED ASTAIRE, U.S. dancer

18. WHERE WILL ALL THE FLOWERS GO? In recent years there has been a mysterious worldwide depletion of the honeybee population. Who knows why? Ecologists hope to diagnose and reverse the situation, since the ultimate impact on the environment could be serious if bees are removed from the food chain.

Recently a quote has circulated on the Internet: "If the bee disappears from the surface of the earth, mankind would soon perish."

19. QUITE A CHALLENGE. On the 1984 *Challenger* flight, 3,300 bees, housed in a special box, adapted to zero gravity and built a nearly normal comb. But they didn't go poo. Since bees excrete only outside the hive, they held it for seven days. A NASA spokesperson said the space hive was "just as clean as a pin."

And upon return to Earth, they carried on exactly as before. Not even a photo-op. Now that's discipline.

20. BEE NICE. According to an old wives' tale, a bee entering your house means that a visitor is on his way, and if you kill the bee, the visit won't be a pleasant one. Suffice

it to say: invite that unexpected honeybee guest to sit down to tea.

Do you take yours with sugar or honey?

* * *

BEFORE WE BUZZ OFF . . .

Bee biz is the basis for thriving cottage industries in the U.S. and around the world. Bee farms are marketing a variety of flavors and grades of honey for consumption. And medical research still focuses on bees.

An alternative "bee sting therapy" movement is getting mixed reviews from doctors and scientists. People with certain diseases, including multiple sclerosis, claim that regularly applied bee stings ease their symptoms; researchers are trying to understand what biological or immunological mechanism—other than the placebo effect—might be at work in these cases, most of which are anecdotal.

Given the value bees have had to the world, we would not be surprised to see some positive results from this research. Meanwhile, the jury is still out.

Our treasure lies in the beehive of our knowledge. We are perpetually on the way thither, being by nature winged insects and honey gatherers of the mind.

—*FRIEDRICH NIETZSCHE,*
German philosopher

20 THINGS YOU DIDN'T KNOW ABOUT BIRTH

Birth is not only about making babies. Birth is about making mothers . . . strong, competent, capable mothers who trust themselves and know their inner strength.

—BARBARA KATZ ROTHMAN, Professor of Sociology, City University of New York

We were all birthed. It's unlikely any of us remember the experience. But anyone who ever gives birth is unlikely to forget it. Birth is among the Great Mysteries—unexplainable, terrifying, inspirational, magical, painful, joyous. How and why new life comes to the world is something we can only contemplate with awe.

Different creatures handle this mystery in different ways.

* * *

1. COUNTING THE MINUTES. From conception to delivery of a new human takes about 38 weeks. That's 266 days or 6,384 hours. Only about 5% of births occur on the "due date." That's because it's the baby, not the doctor or the calendar, who decides when it's time.

Giving birth is like taking your lower lip and forcing it over your head.

—CAROL BURNETT, U.S. comedienne

When the time comes, the uterus begins contracting regularly, and the cervix dilates several inches. How long this lasts depends upon the mother. At this time decisions are made about heading for the hospital, medications if any, calling the midwife for home birth, etc.

Birthing quickens with stronger uterine contractions over the next quarter hour or so and the mother's overpowering urge to push the baby out. The baby gets its head aimed at the exit. Labor begins. Gradually, then suddenly, the crown of the baby's head emerges. Welcome to Planet Earth, kid.

The stage between birth and the expulsion of the placenta usually takes about 10 minutes. If the placenta is stubborn, it's not good to try to yank it out; rather, gently massage the mother's lower abdomen until it releases. It is important to monitor the mother to make sure this happens, or she risks infection, hemorrhage, and worse.

I am not finding pregnancy much of a joy. I am afraid of childbirth, but I am afraid I can't find a way of avoiding it.

—*BRIGITTE BARDOT, French actress*

They say you can't have a baby in one month by impregnating nine women, but it just might be worth a try.

—*The Unknown Philosopher*

One in 8 babies arrives sooner then predicted. Births earlier than three weeks before "due date" are considered premature.

"Preemies," with less time to develop in the womb, can suffer medical or developmental problems, often in the lungs. So doctors

sometimes intervene to delay birth when a mother is going into labor too early, to give the baby more time to "cook." Owing to environmental and lifestyle factors, premature births have skyrocketed over 30% in the past 25 years.

2. FEWER AMERICANS? For a dozen years the U.S. birth rate declined, though it now appears to be stabilizing.

There are about 80.5 million mothers in the United States. The most common birth month is August—with odds favoring a Tuesday (see #8) afternoon. (The fewest American deaths happen in August.) Our lengthening life span results in a smaller proportion of women of childbearing age. Birth rates for prime reproductive ages have also plunged. Rates for the 20s and early 30s are generally down, but in mothers 35 to 44 they have trended up and become stable (though not great in numbers) for women over 45.

Babies are such nice ways to start people.

—DON HEROLD, U.S. humorist

3. SENDING IN REPLACEMENTS. It takes 2.1 births per mother to replace the population in Europe. The current average is 1.5 children per woman. Hitting 1.0 would represent cutting the population in half. Japan has one of the world's lowest birth rates at 1.32. South Korea claims the lowest—1.08—according to that country's National Statistical Office.

The world birth rate is about 20 per 1,000 persons. The

highest national rates are mostly in Sub-Saharan Africa. Niger leads with an incredible 50.16 per thousand, Mali at 49.61 per thousand, and Uganda 48.12 (then Afghanistan at 46.21). In general, the developing world's rates hover in the 40s, 30s, and 20s. Europe, the developed West, and East Asia clump in the teens and under.

If we do not voluntarily bring population growth under control in the next one or two decades, then nature will do it for us in the most brutal way, whether we like it or not.

—*HENRY W. KENDALL, U.S. scientist*

4. HEY, A BABY'S A BABY. Statistics from 2006 show out-of-wedlock births at an all-time high—37% that year. Usually associated with teenage mothers, the U.S. teen birth rate is lower than ever. More babies are emerging from the 20-somethings.

Out-of-wedlock births have risen since the late 1990s. Some 4.1 million babies were born in the United States in 2005, more than 1.5 million of those to unmarried women.

This mushrooming of out-of-wedlock children parallels the rise in couples delaying marriage or eschewing it altogether. Birth statistics in the 20s age cohort are consistent across ethnic groups, although the percentage rose most sharply among Hispanics.

The trouble with wedlock is that there's not enough wed and too much lock.

—*CHRISTOPHER MORLEY, U.S. humorist*

The horror of wedlock, the most appalling, the most loathsome of all the bonds humankind has devised for its own discomfort and degradation.

—MARQUIS DE SADE,
cheerful French novelist

5. THE UNKINDEST CUT? Thirty percent of U.S. mothers give birth by Caesarean section, with a growing number choosing that method.

More than 80,000 American women a year have elective, pre-planned C-sections.

The National Institutes of Health is studying the risk-to-benefit ratio of what is, after all, major abdominal surgery. The side effects are rare but can include hemorrhage, blood clots, and infections. Women having C-sections also risk complications with future pregnancies.

Caesareans are a potentially life-saving alternative in some high-risk pregnancies. Fetal distress, multiple births, or the presence of certain diseases are important reasons to have one.

But for some women (and doctors!) it's about convenience—scheduling the birth to fit busy lives. Plan ahead for visiting relatives and friends. Some women fear that something might go wrong with vaginal birth and prefer a planned C-section to an emergency one. Others who live far from a hospital worry that when their water breaks they might not arrive in time.

Since hospitals are often plagued by malpractice suits, many refuse to let women with prior C-sections attempt vaginal delivery with subsequent babies. Some women (only 1%—enough to scare hospital lawyers) can suffer a ruptured uterus during vaginal delivery, which can be life threatening.

There are few data comparing side-by-side results of elective C-sections, birth canal deliveries, and emergency C-sections. Supporters of elective C-sections downplay the dangers for healthy women, pointing out that vaginal birth presents risks like vaginal damage and forceps trauma to the newborn.

6. GIMME THAT OLD-TIME BIRTHING. More women are choosing alternative approaches to childbirth. In this century, more women are choosing water birth, Lamaze, acupressure, yoga breathing, hypnosis, and acupuncture to deal with birth pangs.

For generations the norm—especially in big cities—has been to medicate Mom in a hospital maternity ward. But critics remind us that birth is natural, so we should help mothers cope with the pain and view it as work, not simply mask it by doping them up.

In the early 1990s, only two large American hospitals (and a few birthing centers) had water-birthing facilities. By the mid-2000s, about 250 U.S. hospitals and 70% of birth centers were including it.

Birthing centers are a midway point between hospitals (a place for sick people; motherhood is not a disease) and the home, which may not have the facilities or skilled people to handle unexpected situations. Some hospitals now situate their birthing rooms near delivery and operating rooms, in case of emergencies. Birthing rooms are cheerful, soothingly decorated areas where loved ones can support the mother and welcome the baby.

Mothers who deliver in such friendly circumstances speak glowingly

of the sense of comfort, contrasting it to the feelings of fear, isolation, and clinical coldness that characterize big hospital delivery rooms. Most birthing facilities keep emergency equipment handy. Still, about 10% of all deliveries present problems that would be better treated by physicians in a regular hospital.

7. WHEN THINGS GO WRONG. The March of Dimes notes that each year 150,000 babies are born with birth defects, while the American College of Obstetricians and Gynecologists (ACOG) says that 3% of all babies born in the U.S. have some abnormality. Most babies born with congenital defects have two normal, healthy parents.

Natural childbirth has evolved to suit the species, and if mankind chooses to ignore her advice and interfere with her workings we must not complain about the consequences. We have only ourselves to blame.

—*MARGARET JOWITT,*
Association of Radical Midwives

Birth defects are aberrations of structure, function, or chemistry that develop in the womb, usually in the first trimester. Some are obvious; others are detectable by testing. Of 4,000 known birth defects, many are treatable, even curable, immediately after birth—increasingly while the baby is still in utero. Sadly, other abnormalities bring severe physical or mental impairment, or are fatal within a short time. Birth defects are the No. 1 killer during a baby's first year.

Birth defects can be genetic, caused by environmental factors (radiation) or maternal behavior during pregnancy (smoking, alcohol or drug abuse, STDs and other infections), or caused by unexplainable factors, including gene mutation.

Structural defects are those in which a body part is missing or deformed (spina bifida; cleft lip). The most common are cardiac related (one of every 100 babies in the U.S. is born with an abnormal valve, chamber, or blood vessel).

Metabolic defects result from some deficiency, overabundance, or aberration in body chemistry. These affect about one in 3,500 babies and are usually traceable to an incorrectly formed (or totally absent) enzyme. They are often dangerous or even fatal, but they usually present no visible symptoms. Metabolic defects include Tay-Sachs disease, a fatal central nervous system ailment, and phenylketonuria (PKU), which interferes with protein processing.

The baby is fine; the only problem is that he looks like Edward G. Robinson.

—*WOODY ALLEN, U.S. comedian*

8. WEEKENDS OFF? Uterine contractions are triggered by hormones, not by calendars. Therefore, absent physician intervention, births should be evenly distributed across seven days—about 14% on any given day. Not so. In the U.S., more babies are born during the work week—slightly more than 14% from Monday through Friday! Only 12% come on Saturday, and a mere 10% are Sunday babies.

Tuesday is the day most babies were born in 2004.

Somewhere on this globe, every ten seconds, there is a woman giving birth to a child. She must be found and stopped.

—*SAM LEVENSON, U.S. humorist*

9. BEYOND TULIPS AND CHEESE. A Dutch study says that women who work high-stress jobs during pregnancy risk their babies' having low birth weight, crying more, and possibly contracting diabetes and heart disease. A researcher recommends working no more than 24 hours a week.

Some employers would like pregnant women to work zero hours a week. Pregnancy discrimination and improper dismissal suits are on the rise. Suits filed with the Equal Employment Opportunity Commission (EEOC) shot up 39% between 1992 and 2003.

On the one hand, we'll never experience childbirth. On the other hand, we can open all our own jars.

—*BRUCE WILLIS, U.S. actor*

More women of childbearing age are in the labor force than ever. Women are 47% of America's total work force and are projected to be more than half the increase in nationwide employment through 2012, according to the U.S. Department of Labor.

The average age of Dutch women who give birth to their first child is 29.4 years. American women give birth for the first time at an average age of 25.2 (a record high for the U.S., first reached in 2003).

10. AS YOUNG AS YOU FEEL. In 2007, psychologist Frieda Birnbaum of New Jersey became the oldest woman (60) in the U.S. ever to bear twins. Both were born via C-section. She went for in vitro fertilization at a South African center specializing in older women. Her 3 other children are 33, 29, and 6.

In 2006 a 59-year-old New Jersey woman gave birth to twins. An Austrian woman became a first-time mom at age 61, then bore her second child at 66. The oldest mother in the world to give birth was a 67-year-old Spanish woman.

A strong positive mental attitude will create more miracles than any wonder drug.

—PATRICIA NEAL, U.S. actress

11. HO HUM, BACK TO WORK. Great Britain's Palak Vyas is believed to have managed the world's quickest birthing ever registered. She was in labor for only 2 minutes—after pushing once. Her daughter, at a hearty 7 pounds 2 ounces, was apparently unfazed as well.

I've learned it hurts just the same, whether you're pushing a little extra or not.

—DAN O'BRIEN, U.S. athlete

12. DON'T TRY THIS AT HOME. The youngest known parents were a 9-year-old boy and an 8-year-old girl in China. A Moscow 4th-grader left school after revealing that she was 30 weeks pregnant. The world's youngest grandmother—just

28—is a Ukrainian woman whose 11-year-old daughter gave birth to a healthy boy via C-section.

In 1930, Russia claimed the world's youngest mother, just 6 years old. That record was eclipsed in 1939 by a 5-year-old Peruvian girl. They grow up faster in the tropics.

13. EXOTIC CONTRACEPTIVES IN HISTORY. Crocodile and elephant dung were the first known contraceptives, used by Egyptians and Indians 3,000 years ago. The excrement was thought to have mystical spermicidal powers. Right. When packed into the vagina, it probably did prevent pregnancy—acting as a highly effective penis repellent.

In the Middle Ages, superstitious women wore amulets filled with mule's earwax and weasel testicles, and took the bone of a black cat to avoid pregnancy. (We beg you—picture the harvesting process!) Casanova had ladies use half a lemon as a cervical cap. Chinese women went so far as to drink lead and mercury, leading to sterility and usually the ultimate birth control—death.

The world's biggest collection of contraceptive devices is on display at the History of Contraceptives Museum in Toronto.

My best birth control now is just to leave the lights on.

—*JOAN RIVERS,*
U.S. comedienne

14. UH, REMEMBER THAT WILD SPRING BREAK? In 2006, researchers at the University of California warned that women with large tattoos on their lower backs may risk more pain

during childbirth. This popular area for ink-filled butterflies is also the preferred site for epidural anesthetic. The injection may transmit tattoo ink into deep tissues, causing ugly reactions. Many, though, dismiss the risk as an urban legend.

Giving birth was easier than having a tattoo.

—NICOLE APPLETON,
Canadian musician

15. MR. MOM. The seahorse is the only male that gives birth. The female inserts her ovipositor into her guy's brooding pouch. She deposits eggs, which he fertilizes by releasing sperm into the water. Fertilized eggs are quickly enclosed by tissues, which fasten to his pouch wall for two or three weeks until the eggs hatch.

Speaking of horses, a pony in England beat 10,000-to-1 odds by giving birth to twins. Amazingly, both survived. Usually one, and often both, die because a mare's uterus can't support two foals. Twins account for about 15% of all thoroughbred pregnancies. Only 10% of the time do both foals survive.

I like trying to get pregnant. I'm not so sure about childbirth.

—GEORGE ELIOT, British novelist

16. HERE COMES LUNCH. For three days in Mumbai, a sand boa gave birth to 22 babies. The babies were kept in a separate tank because the sand boa mother tends to eat its own babies. Most snakes lay eggs that hatch. The sand boa gives birth directly.

Weird. And they are surly, too.

17. VIRGIN BIRTH? In England, in the 1920s, a woman is said to have conceived without having complete intercourse. She had an intact hymen, but that's inconclusive proof of sexual innocence, just as an impaired hymen or the absence of a hymen is no proof of the opposite.

Humans aside, there are many documented cases in about 70 different species of vertebrates (snakes, lizards, and sharks, among others) of females becoming pregnant through parthenogenisis—asexual fertilization in which eggs become embryos. No males need apply. Last winter, 2 virgin female Komodo dragons at the London Zoo became proud mothers.

18. AND THEIR KIDS BECAME PHILOSOPHERS? When ancient Greek women went into labor, the room was checked for knots, which were believed to jinx the birth. One midwife (doula—a word we still use) massaged the belly while the mother crouched over a birthing stool. Another waited beneath to catch the baby. Once the baby was washed, they anointed its forehead to protect it from the "evil eye."

Eighteenth-century French royal mothers-to-be indulged in almond oil to cleanse the doctor's hands, sneezing powder to ease labor, and cumin and myrrh to dust the umbilicus. The newborn was washed in oil, roses, and red wine—perhaps a brave little Beaujolais, just this side of insouciant.

The Chinese in the 1800s summoned a Taoist priest to pray at the woman's bedside, then waited three days before cleansing the child of evil influences.

19. BABY, IT'S COLD OUTSIDE. Eskimos as late as the 1920s made beds for expectant mothers in shallow birthing trenches

covered with animal skin. The father pressed on the mother's abdomen to speed up the birth. After he cut the umbilical cord, the mother would knot it to halt any bleeding. Family animals were given the placenta to feast on.

20. A BIG TRADEOFF. A water birth may help the baby descend twice as fast, but New Zealand doctors mention the increased risk of the baby drowning! Four newborns in their study group, plucked from the drink, were treated for "moderate to severe respiratory distress."

When you're drowning, you don't say "I would be incredibly pleased if someone would have the foresight to notice me drowning and come and help me," you just scream.

—JOHN LENNON, British musician

* * *

GIVING BIRTH TO THE FUTURE?

Modern medical advances have greatly reduced infant mortality for anyone who has access to them. Today's mother-to-be is far safer in the delivery room than when she's driving to the mall. Maternity education has enhanced childbirth as well, preparing women for the birth process and teaching ways to lower the risk of underweight babies or birth defects.

Although most women in the industrialized West still choose delivery in hospitals equipped to handle emergencies, there has been a notable surge in professionally supervised home births. Many new mothers prefer not to be separated for an instant from their newborns, and they get comfort and satisfaction sharing

the birth experience with the entire family. It's become the ultimate do-it-yourself project.

Whatever new fads, developments, frills, and social extras we may add to the reproductive process, human life will probably go on very much as it has. We easily imagine clever new cloning techniques, in laboratorio fertilization, artificial incubation, and other sci-fi whoopies. But for humans, making babies is about more than biology, more even than the continuation of the species. It's about love and family and our clumsy groping toward something that might one day pass for an advanced civilization.

20 THINGS YOU DIDN'T KNOW ABOUT YOUR BODY

There is more wisdom in your body than in your deepest philosophy.

—*FRIEDRICH NIETZSCHE,*
German philosopher

It's indispensable to you; it's your constant companion. You love it, feel its pain, enjoy its pleasures. But when something goes wrong with it, someone else usually has to put it right. Your body may be the closest thing in the world to you, but you know very little about it.

HOMO SAPIENS: BASIC MODEL

STRUCTURE

206 bones*

639 muscles

60,000 miles of blood vessels

*We're born with over 300, which fuse into 206 as we mature.

CHEMICAL COMPOSITION

18% carbon
65% oxygen
10% hydrogen
3% nitrogen
2% calcium
1% phosphorous
1% potassium
and traces of sulphur, sodium, chlorine, magnesium, iron, manganese, and iodine. Unexplainable: intelligent people usually have more than average amounts of zinc and copper in their hair.

BODY WEIGHT BREAKDOWN

54% to 60% water
36% to 42% muscle
18% to 20% fat
18% bone

SENSORY RESPONSES

Electrochemical messages travel through the body at over 200 mph
Sight, sound, touch, cold, and warmth = 0.1–0.2 seconds
Smell = 0.3 seconds
Pain = 0.7 seconds

* * *

1. YOUR BODY IS A WALKING CHEMISTRY LAB. It contains over 40 elements, 99% of them carbon, hydrogen, nitrogen, and oxygen. (Hydrogen and oxygen alone are 87% of your body mass—body cells are mostly water—mixed hydrogen and oxygen.)

Yes, you really are what you eat. Good health depends on balanced body chemistry, about an 80–20 alkaline–acid ratio. A wholesome ratio is 80% alkaline-producing foods (leafy and root vegetables, juice fruits, beans, other legumes, and tubers) and 20% acid-producing foods (proteins like meat, fish, and whole grains).

Food is an important part of a balanced diet.

—FRAN LEBOWITZ, U.S. comedienne

Red meat is not bad for you. Now blue-green meat, that's bad for you!

—TOMMY SMOTHERS, U.S. comedian

You were misinformed. Stress, aggravation, or spicy foods do not cause stomach ulcers. The culprit is bacterial infection (Helicobacter pylori) or sometimes caustic medications like aspirin and ibuprofen. Bacterial ulcers can be treated with antibiotics. For others, use antacids and other stomach-lining medications. So go out for Thai food. And don't stress out over stress!

Part of the secret of success in life is to eat what you like and let the food fight it out inside.

—MARK TWAIN, U.S. humorist

2. OXYGEN CAN KILL YOU. We need it to live. In fact, adult humans need to inhale about 88 pounds of oxygen every day. But concentrated doses for extended periods destroy lung cells, leading to coma and death. Same with water. It's the basis of life, but too much too soon dilutes the bloodstream

and impairs electrolyte balance, possibly leading to cardiac arrest. So breathe and drink responsibly.

Oddities worth noting:

- Women feel more pain than men.
- Human brains continue to generate electrical impulses for more than a day after death.
- Human bones have the same tensile strength as steel but are roughly 50 times lighter.
- You are born with adult-size eyes, but your ears and nose keep growing throughout your life.

What we feel and think and are is to a great extent determined by the state of our ductless glands and viscera.

—ALDOUS HUXLEY, British writer

3. YOUR LIVER IS YOUR LARGEST INTERNAL ORGAN. (Skin is the largest organ overall.) An adult male liver is—especially on Monday nights—about the size of a football. It weighs 3 pounds and lurks in your upper right abdomen, protected by ribs. Other than the brain, it's your most complex, versatile organ. Think of it as the body's chemical processing plant.

Liver function affects almost every bodily process. It filters toxins (purifying a liter of blood every minute), regulates fat digestion, aids hormonal balance. It's also an efficient packager of nutrients, storing and distributing what you need for growth and maintenance. One example: it absorbs glucose from digested food, sends what is needed into the bloodstream, then converts and "shelves" the rest as glycogen for future use. When your body needs

more fuel to burn, your liver reconverts that glycogen into glucose.

A bad liver is to a Frenchman what a nervous breakdown is to an American. Everyone has had one, and everyone wants to talk about it.

—*ART BUCHWALD, U.S. humorist*

A healthy liver processes 720 liters of blood per day.

Your liver stores iron and many vitamins, and it produces blood clotting substances and about half the cholesterol in your blood. The rest comes from food.

We joke about bad eating, like the guy who says his body is a temple where junk food worships devoutly. But the truth is, bad eating does hurt your liver. Fried and processed foods, overeating, and overboozing overwork it. Hey, it's only human. It can break down.

When that happens, body functions suffer. Serious liver conditions include hepatitis A and B (inflammation), jaundice (yellowing from badly filtered blood), and cirrhosis—scarred and hardened liver, with functions crippled. Cirrhosis is often fatal if not treated early. Alcohol abuse is a well-known cause but not the only one. In the U.S., more than half of all cirrhosis is triggered by hepatitis, adverse drug reactions, and diseases.

I couldn't imagine myself walking out of the hospital, let alone standing on a stage performing for 2,000 people, doing jokes and love songs with a burned-out liver.

—*SAMMY DAVIS JR., U.S. entertainer*

Liver cancer is on the rise in the U.S. It is most prevalent among immigrants from Asian countries, where liver cancer is common. It also occurs disproportionately among native Alaskans.

Asians have a high frequency of hepatic cancer because of its link to chronic hepatitis B (HBV), rampant in Asia. (Two worldwide "frequency" maps, one showing HBV infections, the other showing liver cancer, will virtually overlap.) Roughly 75% of all liver cancer cases are in Southeast Asia. It is also common in sub-Saharan Africa and other parts of the developing world. Infection is less common in Western Europe and North America, where fewer than 1% have HBV infections. The World Health Organization estimates that 8% to 10% of the general population throughout the developing world are chronically infected with HBV. In those areas, liver cancer remains among the top three causes of death by cancer in men.

Why? Analysis of patients with both HBV and liver cancer often reveals genetic material from the hepatitis virus mingled with the genetic material of the cancer cells. This suggests that elements of the HBV's genetic code invade the liver's genetic material, destabilizing normal cell function and triggering malignancy.

A census taker once tried to test me. I ate his liver with some fava beans and a nice Chianti.

—DR. HANNIBAL LECTER (ANTHONY HOPKINS),
The Silence of the Lambs *(1991); novel,*
Thomas Harris; screenplay, Ted Tally

A healthy—OK, even an appetizing—liver is important to maintain through sensible diet, exercise, and supplements gen-

erally viewed as beneficial. Among these: vitamin C (boosts immune function) and certain herbs like milk thistle and herbal licorice (but not necessarily Good 'N Plenty licorice candy).

4. YOUR HEART IS IN THE RIGHT PLACE. But that isn't on the left side of your chest. It's near the center, between the lungs. It angles slightly left, which is where you notice its beating. In most adults, the heart is about twice the size of a fist.

A normal heart beats about 100,000 times a day—35 million times a year. Assuming an average life span, your heart will beat between 2.5 and 3.0 billion times, pumping some 55,000,000 gallons of blood! An industrious little muscle indeed. About 6 quarts of blood circulate through your entire system every 20 seconds. Each 24 hours, that blood travels 12,000 miles. Your heart muscle uses about the same force to pump blood as you'd use to squeeze a tennis ball, which can squirt a stream of blood about 30 feet.

If you haven't got any charity in your heart, you have the worst kind of heart trouble.

—BOB HOPE, U.S. comedian

The aorta, the largest artery in the body, is as wide as a garden hose. If you were to unravel all the blood vessels, including capillaries, in your body, they'd stretch 62,000 miles, about two and a half times around the Earth. Capillaries are so tiny that 10 of them braided together could fit inside a human hair.

Two things are bad for the heart: running up stairs and running down people.

—BERNARD BARUCH, U.S. financier

The human heart continues to beat even when removed from the body or cut to pieces.

5. LOCATION, LOCATION, LOCATION. How long your body lasts depends partly on where your body is living. According to a World Bank survey, worldwide average life expectancy has risen to 67. Japan's expected age is 81; public-health, AIDS-challenged Swaziland a mere 32.6.

A report ranking more than 170 countries according to various factors revealed that the best places to live were overwhelmingly Western societies. For the fourth straight year, Norway topped the list, followed closely by Sweden, Australia, Canada, the Netherlands, Belgium, Iceland, the U.S., Japan, and Ireland. Most endangered: Niger, Burkina Faso, Mali, and Sierra Leone. Norwegians born between 2000 and 2005 have an estimated life of 78.9 years; Zambians born those same years can expect only 32.4.

There's lots of people in this world who spend so much time watching their health that they haven't the time to enjoy it.

—JOSH BILLINGS, U.S. humorist

Perhaps unsurprisingly, the following "healthiest places" have universal health care progams: Norway, Sweden, Australia, Canada, the Netherlands, Belgium, Japan, and Ireland. The U.S. and Iceland seem uninterested in that social service.

Life expectancy would grow by leaps and bounds if green vegetables smelled as good as bacon.

—DOUG LARSON, British racer

6. ANIMAL, VEGETABLE, MINERAL. Your body is made up of about 100 trillion cells, most of which are microbes: fungi, bacteria, viruses, and other alien particles. Your skin alone hosts more living organisms than the total human population of Earth.

Your gut is home to about 2.2 pounds of bacteria—even before the chili down at Paco's. There are more bacteria than human cells in and on your body. Every square inch contains an average of 32 million bacteria. In fact, about 10% of your dry weight is from bacteria, so consider personal hygiene when dieting. There are more bacteria in your mouth than people in North America.

Man . . . is a colony of cells in action, and that it is the cells which achieve, through him, what he has the illusion of accomplishing himself.

—*ALBERT CLAUDE, Belgian scientist*

For the first half of geological time our ancestors were bacteria. Most creatures still are bacteria, and each one of our trillions of cells is a colony of bacteria.

—*RICHARD DAWKINS, British scientist*

7. IT AIN'T NECESSARILY SO. Despite the biblical story of Adam trading a rib for a wife, men have the same number of ribs as women. In each case, 24. One of every 20 humans has one pair more or less.

8. YOU'RE PROBABLY NOT MULTITASKING AS WELL AS YOU THINK. Neurological research shows that most people should

not try to do too much at once. Distractions impede performance because of human cognitive limits.

Driving while talking on a cell phone, even with a headset, reduces awareness levels and cuts response time up to a full second—lethal at 60 mph.

Young brains fire faster. But they're easily distracted, and they take longer to regain efficiency, according to Oxford University researchers. Test groups of 18 to 21-year-olds and 35 to 39-year-olds were given 90 seconds to code images into numbers. The youngsters were 10% more efficient when not interrupted. But after interruptions to both groups, they performed no better than the oldies.

Genius is nothing but continued attention.

—*CLAUDE A. HELVETIUS,*
French philosopher

Microsoft estimates that it takes its workers 15 minutes to regain momentum after interruptions. Lost productivity, according to Jonathan Spira, business analyst at Basex, costs the U.S. economy $650 billion a year.

9. LEFT-LEANING? About 17% of us are left-handed—50% more males than females. (True of gorillas and chimps also!) Lefties are better at sports that require keen spatial judgment and fast reaction. But there's no evidence that they are smarter or more creative than right-handers. Left-handedness is associated both with high achievement and with neurological disorders like Down's syndrome, dyslexia, and autism.

Some famous left-handers: Einstein, da Vinci, Nikola Tesla, Picasso, and seven U.S. presidents. Goethe, Garbo, Goldie Hawn, Benjamin Netanyahu, Rex Harrison, Richard Simmons, Cary Grant, Julius Caesar, Sid Caesar, Paul McCartney, Ross Perot, Fidel Castro, Charlie Chaplin, Jay Leno, Nelson Rockefeller, Alexander the Great, George Burns, Tom Cruise, Nicole Kidman, Raphael, David Letterman, Edward R. Murrow, Pelé, Harpo Marx, Benjamin Franklin, M.C. Escher, Oliver North, Rock Hudson, Oscar Wilde, Robert De Niro, Vincent van Gogh, H.G. Wells, Michelangelo, W.C. Fields, Steve Forbes. Also Jack the Ripper, John Dillinger, the Boston Strangler, Billy the Kid.

It starts early. Whichever thumb an embryo sucks usually correlates with the child's subsequent handedness. Some theorize a connection between left-handedness and high uterine testosterone levels; others suggest that right-brain emphasis implied by left-handedness may incline babies toward artistic creativity.

I'm used to being in the minority. I'm a left-handed gay Jew. I've never felt, automatically, a member of any majority.

—*BARNEY FRANK,*
U.S. congressman

People tend to chew their food on the same side as their dominant hand. Southeast Asia and Eastern Europe have the most lefties in the world. It is comparatively uncommon among Europeans and Africans. Right-handers live, on average, nine years longer than left-handed people. (Maybe partly because left-handed people are injured or killed using machinery or implements designed for right-handed people?)

10. YOU'RE ALL WET. According to some water industry estimates, the average American uses 3,000 gallons of water a month for all purposes. That means 12,000 for a family of four. Over a typical lifetime, we will each generate about 10,000 gallons of saliva and 12,000 gallons of urine.

We lose water through 2,000,000 sweat glands (250,000 in our feet alone), also via exhaled breath and elimination of waste.

A human being is an ingenious assembly of portable plumbing.

—*CHRISTOPHER MORLEY,*
U.S. humorist

Water is the only substance naturally present in all three states of matter—liquid, solid (ice), and gas (water vapor or steam). It's present in two of those forms in your body. For your sake we hope there's neither ice nor steam. Your brain is 75% water, 22% bones, over 80% blood. Less than 3% of all water on Earth is drinkable; 90% of it is in Antarctica—for the moment. Be very worried.

Mom was wrong. You don't need to go "big potty" once a day to be healthy. "Regularity" of bowel movements varies greatly, depending upon individuals and their diets. Some people go more than once a day; others just three times a week.

11. MEN DON'T KNOW DICK ABOUT THEIR PETER. There are two schools of penis. One expands and lengthens during erection; the other looms large while at rest but expands comparatively little when aroused. There is no correlation

between hand, feet, or nose size and penis dimension. Penis size is determined by penis genes, hand by hand genes, and so forth. The shoe, glove, and condom industries have nothing to say in the matter.

God gave us a penis and a brain, but not enough blood to use both at the same time.

—*ROBIN WILLIAMS, U.S. comedian*

Although the brain is the body's main erogenous zone, ejaculation is not necessarily a function of the conscious mind. The ultimate trigger is in the spinal cord, responding to nerve stimuli.

12. OPPORTUNITIES IN THE SKIN TRADE. Foreskins removed during hospital circumcisions are sometimes sold to biotech labs, since young skin is ideal for researching methods for growing replacement skin for burn victims, insulin manufacture, and also making skin creams for ladies. One infant foreskin can be grown into literally thousands of square feet of new tissue. No wise-guy comments necessary.

Cost? Prices vary according to cell quality. A product called Dermagraft-TC goes for about $3,000 a square foot. One baby's loss typically contains enough genetic material to develop 250,000 square feet of new skin. Do the math. You'll see the potential of the foreskin futures market. (Do parents get royalties?)

Seekers of research foreskin can contact companies such as Advanced Tissue Sciences (ATS), Organogenesis, Bio-Surface Technology, Genzyme, and Ortec International.

Man consists of two parts, his mind and his body, only the body has more fun.

—*WOODY ALLEN, U.S. comedian.*

13. YOUR SCALP HAS 100,000 HAIRS. Redheads have 90,000; black-haired people, 110,000. Head hair grows about 5 inches a year. Humans are as hairy per square inch as chimps but don't show it, since most hairs are too fine to be seen. Individual hairs live anywhere from 2 to 7 years (eyebrow hair 3 to 5 months). An adult human head weighs more or less 8 pounds, even without hair. Hair analysis is like a fossil record. It can reveal drug use, nutritional habits, and many aspects of your health. It cannot reveal gender.

Hair has always been important.

—*DIANA ROSS, U.S. singer*

I'm not offended by all the dumb-blonde jokes because I know that I'm not dumb. I also know I'm not blonde.

—*DOLLY PARTON, U.S. singer*

Hair grows at a different pace (and thickness) depending on ethnic factors. Asian hair grows fastest, has the greatest elasticity, and is less prone to balding than African or European hair.

An average man will shave 60 hours a year; 5 months of his life will be spent peering at his sleepy, soapy face in the mirror. No such time was wasted by Hans Langseth of Norway and North Dakota (1846–1927), who grew the longest beard on record: 17.5 feet. Upon

his demise it was clipped and donated to the Smithsonian Institution. A Sikh in India (Shamsher Singh) currently sports a beard longer than 6 feet.

14. IT IS NOT NATURAL TO LOSE TEETH FROM OLD AGE. Teeth should last as long as the rest of you—or longer, with good oral hygeine and regular professional care. Periodontal (gum) disease, not tooth decay, is the main cause of tooth loss (and low-grade infections) in American adults. Some of this is neglect, but about a third of the population is genetically predisposed to gum disease. The tooth is the only part of the human body that can't repair itself.

You don't have to brush your teeth, just the ones you want to keep.
—*ANONYMOUS*

There is a close correlation between periodontal disease and systemic illnesses, including cardiovascular disease, diabetes, low birth weight in babies, and more.

Oral health is central to overall health, not just to a pretty smile. The main villain is gum disease, which can reduce life expectancy. Other factors that can weaken systemic health and cause infection are tooth decay, allergic reactions, infected root canals or extraction sites, and various non-gum oral diseases. The more of those conditions you have, the greater the likelihood of weak resistance to disease, which compounds the seriousness of any illness.

Recent developments in computer imaging (even at local dentists),

technology, and treatment options—combined with heightened awareness and early detection—can counter the threat of illness.

I told my dentist my teeth are going yellow. He told me to wear a brown tie.

—*RODNEY DANGERFIELD, U.S. comedian*

Dr. Brady Barr of *National Geographic* measured the bite force of various animals and humans. Healthy humans are capable of between 100 and 200 pounds psi biting pressure. Large dogs (Rottweilers, German shepherds, pit bulls) registered 320 pounds; wild dogs, 310; lions and white sharks, 600; hyenas and snapping turtles, 1,000; crocodiles, 2,500.

She laughs at everything you say. Why? Because she has fine teeth.

—*BENJAMIN FRANKLIN,*
American statesman

15. PASSING WINDS OF HISTORY. The Emperor Claudius compassionately ordained that "all Roman citizens shall be allowed to pass gas whenever necessary." One hopes it was necessary outdoors more than indoors. Sadly for gassy Romans, Constantine—the first emperor to convert to Christianity—overturned that ruling in 315 B.C. No gas shall pass. Ever since, Christians have been reduced to passing gas surreptitiously when in church.

Most people produce around a quart of gas and release it about a dozen times a day. Intestinal gas mixtures depend upon which bacteria are working on undigested food in the colon. Since vegetable cellulose is indigestible, vegetarians

are gassier than omnivores. Male and female digestion follow the same chemical breakdown rules, so there is no major difference between genders regarding gas production and emission. Put bluntly, anyone who eats, farts.

The main components of intestinal gas (flatus) are, interestingly, five odorless gases (nitrogen, hydrogen, carbon dioxide, methane, and oxygen). Flatus is flammable because of the hydrogen-methane combination. From the time they begin forming in your system until they exit is between half an hour and 45 minutes. So time that romantic dinner carefully.

16. HAIR AND FINGERNAILS ARE TWO VERSIONS OF THE SAME SUBSTANCE, KERATIN. Next to bone marrow, hair is the fastest growing tissue in your body. Fingernails all grow at different speeds, averaging around 2 cm a year (fingernails four times as fast as toenails). Slowest: thumbnail. Fastest: middle finger, for reasons unknown. From frequent extending during moments of road rage? Equally mysteriously, many women lose sensitivity in their middle fingers when menstruating.

For three days after death, hair and fingernails continue to grow but phone calls taper off.

—JOHNNY CARSON, U.S. comedian

Hair and fingernails just appear to be growing because of the body's post-mortem shrinkage and dessication. But it is a good line.

17. SAY CHEESE. Frowning requires more muscles than smiling, possibly to punish your face for being negative.

Humans have the most facial muscles of any animal, 22 on each side of the face.

18. OH, MY ACHING BACK! You're not alone. Next to headaches, your back is the most likely body part to cause misery. Tension headaches and hangovers are mostly vascular in origin, while more serious—and more mysterious—migraines are usually neurological.

Some 65,000,000 Americans have back trouble each year. Four out of five American adults groan from lower back pain (LBP) at some time in their lives. Next to colds and flu, LBP is the most common reason for absenteeism among workers over 45.

19. EYES WIDE SHUT. Most people blink about 17,000 times a day, or 6,205,000 times a year. Women blink nearly twice as frequently as men.

Many people suffer from dry eye syndrome, caused by insufficient natural moisture. This ranges from minor irritation to painful irritation and often the feeling that some foreign object is in the eye.

Other than expressing emotions, tears are useful because they release enzymes to destroy microorganisms on the eyeball. Dry eye syndrome happens when eyes don't produce enough tears. This can be a consequence of aging or a reaction to antidepressants, antihistamines, birth control pills, or blood pressure medications. Another cause: not enough blinking—as when you peer at a computer screen for hours at a time.

20. LET IT BREATHE. Your brain hogs more than a quarter of your body's oxygen. Brain cells live longer than any other cells

in your body; some last your entire life. Researchers at Princeton have discovered that despite long-standing belief to the contrary, cells in the cerebral cortex—the brain's most complex area—can regenerate.

Although the Princeton research was done on monkeys, scientists are hopeful about the chances for unravelling the secrets of brain cell growth. This would lead to advances in treating brain injuries and illness. The reason for optimism: humans and monkeys have similar brains and nervous systems—even beyond a common fondness for bananas.

* * *

TAKE A GOOD LOOK NOW, BECAUSE YOU WON'T LOOK LIKE THIS FOREVER

We have inherited—and maintain—our image of the human body from ancient and classical art. Whether those representations are primitive, idealized, or realistic, all contribute to body self-image. Despite the best sci-fi special effects, we easily distinguish humans from humanoids and other aliens. Even in vastly distant futures depicted on film—no matter how glitzy the technology, architecture, and costuming—humans are still humans, subject to aging, illness, and death. They may have phasers and light sabers, but at some point they also have gray hair, wrinkles, and paunches.

But must it be forever so?

Current work on bionics, cyborg development, and other "transhuman" technology may provide an accelerated—even a forced?—evolution of the human body, and consequently what we will consider a "human" body. Even today we can imagine future "humans" living for hundreds of years, illness free, sustained by

electronically boosted nervous systems, computer-enhanced brains, synthetic blood, and superstrong muscles and bones. It's worn out? Replace it. But how will changed body capabilities affect our culture and own values?

Golly, imagine the perfection of the nose jobs.

20 THINGS YOU DIDN'T KNOW ABOUT DEATH

Life is better than death, I believe, if only because it is less boring, and because it has fresh peaches in it.

—ALICE WALKER, U.S. author

Death—the ultimate question mark. Ever since humans became conscious of being alive, we have also been conscious that eventually we will stop being alive. And we have no idea why. Why would nature go to all the trouble of making us live, only to make us stop living?

Death is widely viewed as a finality: last stop, everybody out. Yet, untold millions view death as merely a transfer point for the next stage of the journey. Most institutional religions hold this view and go to great lengths to explain how we can succeed in their afterlife of choice.

Here we offer no opinion, theology being beyond the scope of this chapter. Instead, we simply pass along some curiosities and anecdotes about the mystery we call death.

Death is a very dull, dreary affair, and my advice to you is to have nothing whatsoever to do with it.

—W. SOMERSET MAUGHAM, British author

* * *

1. SORRY, YOU CAN'T GO BACK. Medically, death is usually defined as the event when an organism's life functions stop: an irreversible cessation of brain and body activities.

In practical terms, death comes when our heart stops beating; we stop breathing, and all higher brain functions turn off. All systems are no-go. There are legal issues regarding more precise definitions, such as exactly when death is death and not a persistent vegetative state, in which the body is kept artificially "alive" in the sense of cellular exchange and the continuance of lower life functions.

It is possible to provide security against other ills, but as far as death is concerned, we men live in a city without walls.

—*EPICURUS, Greek philosopher*

2. MANY WAYS TO SAY GOODBYE. How we handle our departed varies greatly from culture to culture, as do attitudes and customs surrounding our farewells. Every culture has rituals for the respectful disposition and memorialization of its deceased. No true civilization casually throws its dead away.

Always go to other people's funerals; otherwise they won't come to yours.

—*YOGI BERRA, U.S. Baseball Hall of Famer*

Funerals are for the living. They provide a way to say goodbye. All cultures share principles for this goodbye. All follow group ritual; all have sacred burial or disposal places; all memorialize the departed. Even the Neanderthals

(50,000—60,000 B.C.) had burial grounds with bodies decorated with animal horns or antlers and the remains of flowers.

A funeral confirms the reality and finality of an individual's existence. It gives us a chance to express grief, to create a temporary community of sorrow, uniting those left behind into one family—perhaps for the only time in their lives.

Funerals provide an opportunity for family and friends to share emotional support, and they teach mourners to face their loss by expressing their feelings.

Primitive man lived in a world of fear. Seeking a truce with death, he invented rituals to placate unseen forces. We often find ancient burial customs weird and repugnant, but they arose for a reason. The first funerals were crude attempts to protect the living from the spirits that took the dead person. Some tribes would hurl spears and arrows into the air, or shout or eat bitter herbs to drive away death spirits trying to invade the living.

3. TRADITION, TRADITION. In ancient Greek, Jewish, and Roman funerals, the deceased was not embalmed but washed in warm water, sometimes with olive oil. Often the cleansing was done by women of the family. Romans and Greeks might modestly adorn the deceased. But in Jewish tradition, the deceased was (and usually still is) wrapped unadorned in a simple white shroud and buried in a plain pine coffin. All three cultures practiced burial in ground that was considered holy. Romans prepared their dead for burial by first closing their eyes and placing coins on them, and placing a coin in the mouth to guarantee fare across the River Styx. Then—depending on social class and

level of wealth—family members or slaves washed the body for several days with warm water and anointed it with olive oil and perfumes. In the fourth century B.C., cremation became more common than burial. Funerals were often held at night to reduce the likelihood of unwanted crowds or rowdiness.

I do not believe in an afterlife, although I am bringing a change of underwear.

—WOODY ALLEN, U.S. comedian

In medieval Europe, embalming was rarely practiced. Yet, since bodies were needed for dissection by medical students, some embalming was done to preserve cadavers.

Fast-forwarding through the history of anatomical preservation:

Leonardo da Vinci (1452–1519) produced hundreds of anatomical drawings based on his dissection of cadavers. He almost certainly used arterial injection to preserve his subjects—an indispensable step toward scientific embalming.

Frederick Ruysch (1638–1731), "the father of embalming," created the first thorough system of arterial embalming.

Dr. William Hunter (1718–1783) was the first to successfully adopt arterial injection to preserve corpses.

Jean Gannal (1791–1882), a former pharmacist's helper, was the first to offer embalming to the French public.

Alexander Butlerov (1828–1866) and Wilhelm von Hofmann (1818–1892) developed the preservative formaldehyde.

Dr. Thomas Holmes (1817–1900) is considered the father of modern embalming because of his work with preservative chemicals in the New York coroner's office.

4. DEATH AMERICAN STYLE. Sometimes called the father of modern embalming, Dr. Thomas Holmes of New York was an Army Medical Corps captain during the Civil War. He and his staff embalmed some 4,000 KIAs. President Lincoln appreciated the role embalming played in returning the Union dead home in a dignified and sanitary manner. Embalming was rare for Confederate dead.

Dr. Holmes quickly saw potential in the funeral business, and he left the military to provide civilian embalming services at $100 a pop—far better than Army pay. Historical aside: Once the war was over, since there were far fewer dead people—and also fewer trained embalmers—many undertakers reverted to preserving corpses with ice.

5. BURN MY WIFE—PLEASE. In some cultures, suicide was respectful funeral etiquette. In ancient Japan, slaves committed seppuku (ritual suicide) to honor their dead master. (Clearly, employee retention was not a high priority.) In Fiji, besides wives and slaves, friends of the deceased were strangled to join him in death. To Western eyes, the Hindu custom of suttee (wife burning) seems really sick—even for those of us who have had difficult marriages. The widow had to don her finest outfit, then recline alongside her late husband on the funeral pyre while their eldest son torched them to paradise.

Fire has a close connection with death. Primitive tribes often burned bodies to destroy evil spirits lurking therein. Zulus even burn possessions of the deceased to keep evil spirits away. Other tribes set a ring of fire around the deceased to scorch death spirits and prevent them from attacking mourners. Zoroastrians—fire lovers—preferred to let their dead rot or even be eaten by vultures. Fire was too

sacred to use for a lowly purpose; burying a decaying corpse was considered insulting to Mother Earth.

Our word "mausoleum" derives from the Mausolus, King of Caria (in modern-day Turkey, then Anatolia), whose memorial tomb was one of the Seven Wonders of the Ancient World. When he died in 353 B.C., he was cremated. His wife Artemesia did not join him in the flames like some loyal Hindu widow. Instead, she mixed his remains with water (some say wine) and drank them. Now, that was one earthy dame.

6. GENDER DISCRIMINATION AFTER DEATH. For better or worse, dead males in some cultures have been treated differently from dead females. Primitive examples: the Cochieans buried women but hung men from trees. The Ghonds buried women and cremated men. The Bongas buried men facing north, women facing south. OK, have you ever heard of Cochieans, Ghonds, or Bongas? Clue.

We have inherited many funeral customs from distant ancestors, including wardrobe hints. Some ancient societies, when saying farewell to their fellows, thought they could keep death spirits away from themselves with clever disguises. If they really believed they could fool the spirits with a quick change of clothes, pagans must have considered them either stupid or myopic.

The face is where eating and breathing happen, so most ancient cultures assumed that our life force leaves through the mouth. When someone became gravely ill, they sometimes tried to trap the life spirit inside the patient by clamping his

mouth and nose shut—which surely killed far more people than it helped. Bad bedside manner.

7. RELIVING THE PAST. Overeating at funerals began in ancient times, when food offerings were made as an affirmation of life. Wakes echo the custom of watching over the deceased, hoping they will "wake" and come back to life. Candles are a variation of the use of fire to protect the living from the spirits. Bell-ringing stems from a medieval belief that spirits are frightened away by the ringing of a consecrated bell.

Military funerals include a rifle volley fired over the deceased hero. What are they shooting at? Probably the same evil spirits that our ancestors tried to chase away by heaving spears or shooting arrows. And why do we offer wreaths at funerals? To wrap around the spirit of the dead and keep it from entering us. Why a determined Death would be so easily fooled by flowers has never been explained.

Either this man is dead or my watch has stopped.

—GROUCHO MARX, U.S. comedian

8. MUMMY DEAREST. The historian Cassius wrote that the Egyptians developed embalming as a solution to the problem of the regular Nile River floods, which would exhume the dead. They apparently understood—although they had no specific knowledge of pathogens—that floating cadavers caused illness and death.

Egyptian embalmers were priests, whose embalming success was due largely to Egypt's hot dry climate. Flesh

decomposes via bacterial action, and heat and aridity thwart bacterial survival and growth.

The Egyptians practiced three methods of embalming (too gruesome to outline here) based on the wealth of the individual—not unlike funeral directors today. All afterlife functions took place within the necropolis ("city of the dead"), a walled enclosure that was off limits to the average Hosep. Within those walls were the embalmers, coffin makers, cosmetic artists, and burial crypts.

9. WHY EMBALM? The main reason is to avoid infection and disease spread through decomposition. Although some pathogens die soon after their host, others survive for long periods in dead tissue. Anyone touching an unembalmed body can become infected. Also, flies and worms can be vectors to spread disease among humans with whom they come in contact.

Embalming also protects the deceased from putrefaction while arrangements are completed for burial, cremation, or entombment. Unembalmed corpses are not good company. There is also the issue of restoration, which offers the psychological value of emotional closure for friends and relatives who want one last look at the departed in a state of natural-looking peacefulness.

Embalming prevents (or at least retards) bodily decomposition by "fixing" cell proteins, much as formaldehyde preserves lab specimens in jars. The embalming fluid kills bacteria and viruses and converts cell albumins into a variety of gels and albuminoids, making it difficult for new invasive molds or microbes to further damage the body.

10. MORE THAN YOU WANT TO KNOW. Once embalmers became competent, there was much less rush to burial. Mourners had more time for funeral arrangements. Early embalming preparations were arsenic solutions, later replaced by formaldehyde.

Just as they do today, nineteenth and early twentieth-century drug reps ran wild across the country. Embalming fluid companies sent salesmen to give one- or two-day seminars on their product. Anyone who took the training sessions and agreed to buy a certain amount of the embalming fluid was automatically certified as a qualified embalmer. This snake-oil approach to mortuary science lasted well into the twentieth century, when states took over the licensing process.

TOP TEN CAUSES OF DEATH IN 2004

Heart disease
Cancer
Stroke
Respiratory disease
Accidents/unintentional injuries
Diabetes
Alzheimer's disease
Influenza/pneumonia
Nephritis
Septicemia

11. I COULDA DIED LAUGHING. Don't laugh; people do die of terminal funny bone syndrome. According to *The Book of Lists,* Greek philosopher Chrysippus (third century B.C.)

expired from hyper-yukking while watching a donkey eat figs. Must have been a slow day. Greek playwright Philemon (c. 236–263 AD) laughed to death at one of his own jokes. Politics indirectly claimed Sir Thomas Urquhart (1611–1660), a Scottish writer who died of laughter upon learning that Charles II had been restored to the throne. And in 1989 a Danish doctor, Ole Bentzen, howled himself into cardiac arrest watching *A Fish Called Wanda*.

Who says the Grim Reaper has no sense of humor?

John Whitson (1557–1629) was an English adventurer whose horsemanship failed him but once, when he fell from the saddle and impaled his head on a spike at his blacksmith shop.

The Roman emperor Claudius I (10 B.C.–54 AD) choked to death on a feather stuck down his throat to help him vomit up some bad (or poisoned?) mushrooms his wife had served him.

Lionel Johnson (1867–1902) was a British poet who fell to his death—from a barstool.

Allan Pinkerton (1819–1884), of detective fame, tripped and fell while out for a walk, bit his tongue as he landed, developed gangrene, and died within the week.

Isadora Duncan (1878–1927), American dancing idol, snapped her neck when her flowing boa snarled in the spokes of her convertible's rear wheel.

Jerome Napoleon Bonaparte (1878–1945)—yes, that Bonaparte family—tripped over the leash while walking his dog in Central Park, New York. He died of head injuries.

King Alexander of Greece (1893–1920) was playing with his pet monkey, who didn't like the game. The animal bit him, and he died of acute sepsis.

12. DEATH IS MY BUSINESS. There are over 22,000 funeral homes in the U.S., employing some 110,000 people. They generate somewhere around $11 billion in yearly revenues, which means that death is an important part of American economic life.

According to the National Funeral Directors Association, the cost of the average funeral hovers around $6,500 (including casket) but can easily rise to $10,000 if we include extra features in our farewell (e.g., burial, obituary notices, office expenses). Cemetery costs are not part of the base expense. This may be one reason why, starting in 2000, about a quarter of all deceased were cremated. Cremation not only saves real estate but is much less expensive than plot burials. That figure was expected to rise to about 38% by 2010 (and there are no upkeep fees if your loved one is enshrined at home).

Japanese funerals are the most expensive in the world, averaging about $30,000. That's mainly due to the scarcity of burial plots on that crowded island nation. It's next to impossible to buy a grave in Tokyo. So price gouging is common, with most families too proud to bicker and haggle over the cost.

13. NOT GHOULISH, JUST INTERESTED. A necrophile is someone with an excessive (sometimes perverted) interest in dead bodies. On the other hand, a person interested in the history of funerals, burial customs, the structure and art of memorials, headstones, crypts, and cemeteries is a taphophile (from the Greek "lover of tombstones"). There are societies devoted to the study and cataloging of burial places and their memorials.

14. NO ROOM FOR BOOMER? One concern mortuary planners must eventually deal with is the land squeeze: humans can make more humans far faster than the Earth can make more earth. Real estate is a real problem in some places.

Real estate developers planning retirement communities for the baby boomer generation are faced with the problem of square footage. Where will they put all those expired boomers?

The multi-billion-dollar death care industry says it's no problem, not by finding ways to avoid death (an issue being tackled by the multi-billion-dollar pharmaceutical industry) but with several burial options.

One is cremation. Burial of "cremains" uses less cubic footage than caskets do. And the cremation rate is rising faster than the death rate. The Cremation Association of North America estimates that by 2025, the percentage will be just under half of all deaths. (Compare this to Japan, which already has a 98% cremation rate.)

Another option is above-ground storage of cremains in a columbarium, a library-like construction with rows of numbered niches. Arlington National Cemetery in Virginia is running out of burial space. Underground plots are reserved increasingly for most senior members of the military. Thanks to columbariums (or columbaria, for you purists), resting places are vastly increased—indeed, nearly unlimited—since it is easier to build upward than to dig outward.

Finally, even ground burial space has new dimensions—downward. Instead of typical family plots covering more lateral space, double- and triple-depth graves are becoming more common.

Death's future appears bright. Enterprising companies will soon offer the service of orbiting cremated remains;

others will return the deceased to the ocean bottom in concrete vessels that can serve a wholesome ecological function as reef habitats.

15. SIZE MATTERS. "Cemetery" comes from the Greek for "sleeping place." The Mount of Olives in Israel is the world's oldest continually used sleeping place. But it's not the biggest. There are several "largest" cemeteries, calculated either by acreage or by burials.

The Valley of Peace in Najaf, south of Baghdad, claims to be the world's largest, containing about 5,000,000 graves. Shi'ites worldwide crave burial there because it's near the Imam Ali Shrine, one of the holiest Shi'ite sites.

Ohlsdorf Cemetery in Hamburg, Germany, seems the largest overall, at nearly 1,000 acres, approaching 1,000,000 plots and nearly half a million cremations (informally extrapolated from 1996 statistics). The Zentralfriedhof in Vienna has registered some 2.5 million burials. London's Brookwood is a spacious 2,000 acres but has fewer than a quarter million burials.

Arlington National Cemetery is a surprisingly small 200 acres (it was once the estate of Robert E. Lee's wife, Mary Anna Custis, a descendant of Martha Washington). There sleep some 300,000 military and other nationally honored deceased.

Hollywood's celebrity resting place, Forest Lawn in Glendale, California, packs a lot of show-biz history into just 300 acres, while Rose Hills Memorial Park in Whittier, California, at 1,400 acres, stakes its claim as the "single largest memorial park in the world."

Dishonorable mention goes to Auschwitz-Birkenau, the Nazi death camp, where 1.5 million people were killed.

16. ENDING IT ALL. In New York City, suicides outnumber murders. There are between 850,000 and 1,000,000 suicides each year in the world. While women attempt suicide more often, men succeed at a higher rate. This is possibly because men are more likely to choose firearms (over half of U.S. suicides are by gun), while women often opt for barbiturate overdose or other means that more regularly fail.

That's the thing about suicide. Try as you might to remember how a person lived his life, you always end up thinking about how he ended it.

—*ANDERSON COOPER,*
U.S. journalist, whose brother killed himself

17. CHOOSING DEATH. Dying can be tricky business in the U.S., especially for those who desperately want to die. Patients suffering unbearably with no hope of recovery or improvement often beg to be allowed to die with dignity—now. But medical professionals are legally (and many say morally) bound to maintain bodily life as long as possible, regardless of the most fervent wishes of the human being trapped in that body.

Most Western societies, led by religious institutions, disallow the euthanasia option. They hold that matters of life and death should be left to God, not humans. That said, there are surely more professionally assisted "mercy finales"

than we know—indeed, more than we can know, since there are many untraceable ways to help a life conclude. The courts uphold a patient's right to discontinue life support, and there is ample precedent for families deciding whether to continue treatment in hopeless cases when patients can no longer decide rationally. The sticky point: can doctors act to hasten the inevitable, desired end?

Suicide is man's way of telling God, "You can't fire me—I quit."
—BILL MAHER, U.S. comedian

Euthanasia is accepted in principle worldwide. But only the Netherlands has legalized physician-assisted suicide. Several U.S. states have tried, but only Oregon has voted in a Death with Dignity Act (1994), allowing doctors to prescribe a lethal drug dose—but not deliver it! Strict parameters exist to ensure that patients requesting assisted suicide are mentally competent, in intractable pain, and determined to end it by ending their lives. (Since 1997, according to the Oregon Department of Human Services, about 200 terminal patients have taken their own lives in the presence of a physician.)

Recent U.S. Supreme Court rulings have done little to resolve this issue.

18. FAMOUS LAST WORDS. Many people who have led colorful lives—especially entertainers and professional wits—pray for a great exit line. Some seem to have actually had the presence of mind to quip their way off stage. Or at least, so witnesses report, accurately or not.

Brendan Behan (1923–1964), irreverent Irish playwright and bad boy, to a nursing nun at his deathbed: "Ah, Bless you, Sister. May all your sons be bishops."

Anton Chekhov (1860–1904), Russian playwright and physician, as he expired from tuberculosis: "It's been a long time since I've had champagne."

Douglas Fairbanks, Sr. (1883–1939), one of the original action hero movie stars, optimistically reporting to a caretaker after apparently suffering a heart attack: "Never felt better."

W. C. Fields (1880–1946), American comic actor known for consuming legendary amounts of martinis, to his longtime mistress, as he lay dying of liver cirrhosis and massive stomach hemorrhage: "God damn the whole friggin' world and everyone in it but you, Carlotta."

Archduke Franz Ferdinand (1863–1914), shot by a Serbian revolutionary in one of the great under-assessments in all of world history (his death led directly to World War I): "It is nothing. It is nothing."

Edmund Gwenn (1875–1959), English actor: "Dying is easy. Comedy is difficult."

Pancho Villa (1878–1923), Mexican bandit and folk hero, assassinated by agents of Gen. Obregón, speaking to reporters at the scene: "Don't let it end like this. Tell them I said something."

Anna Pavlova (1881–1931), Russian ballerina famous for her interpretation of the Dying Swan: "Get my swan costume ready."

Dylan Thomas (1914–1953), Welsh poet, known for heroic drinking bouts: "I've had eighteen straight whiskies. I think that's the record."

Groucho Marx (1890–1977), vaudeville and movie actor of caustic wit: "Die, my dear? Why that's the last thing I'll do!"

Oscar Wilde (1854–1900), Irish playwright and wit, on his deathbed in a flamboyantly decorated Paris hotel room: "Either that wallpaper goes, or I do."

19. BIZARRE DEATHS. Although old age, disease, murder, war, or catastrophes will claim most of us, some folks succumb to freak accidents and other bizarreries. A few piquant examples:

A Romanian circus ended tragically in 1998 when fire-eater Vlad Cazacu belched in mid-performance and blew himself up. Presumably some flammable solution was partially swallowed, and his burp triggered the blast. Since onlookers assumed that Vlad's exploding head was some sort of clever illusion, nobody rushed to help him, and he died quickly.

A zookeeper in Paderborn, Germany, fed a constipated elephant 22 doses of animal laxative and great quantities of prunes, figs, and other cleansing fruits. They worked more quickly than expected. When the gushing began, the zookeeper was giving the animal an enema. The excreta (about 200 pounds of it) knocked the man unconscious, and he suffocated.

When the stripper failed to burst out of the cake at a bachelor party in Consenza, Italy, in 1997, guests wondered why the pastry had showed up but the pasties hadn't. But the girl was there. The unfortunate young dancer died after being packed into the cake.

A Saudi man, camping on a South African mountaintop in 1998, answered his mobile phone during an electrical

storm. He was killed instantly when a lightning bolt homed in on it.

A North Carolina man, awakened from a dead sleep in the middle of the night, grabbed his .38 revolver instead of the phone and pressed it to his ear. Hello? You know the rest.

Toronto police reported that a lawyer, demonstrating the strength of "safety windows" in a downtown skyscraper, crashed through a pane and plunged 24 floors to his death.

Speaking of unintended defenestrations: in 1998 a dance instructor in Lisbon, Portugal, tangoed to death from a fifth-floor window while demonstrating the importance of looking at the ceiling to keep your head high. In Barcelona, yet another dance instructor swooped all the way to the ground from the third floor while demonstrating an intricate dance step.

An earlier spectacular plunge involved French King Henry in 1197, who was reviewing troops from a balcony. Turning away to greet a diplomatic delegation, he stepped backwards and stumbled over his court dwarf, Scarlet, and the two men pitched to instantaneous death.

The universally feared warrior Attila the Hun died on his wedding night in 453 AD. Not from marital excess—indeed, he almost surely died before approaching his young bride. Overeating and overdrinking in the lusty spirit of the occasion, he passed out in his bedchamber and drowned in the blood from a nosebleed.

20. NEAR DEATH OR WHAT? Although nobody seems to make it back from the other side, many people claim to have been

almost there, or there for a moment. They invariably file soothing reports of loving, welcoming light; loved ones beckoning; a sense of total peace and freedom. Are they nuts, or what? Could their experience be real?

Men fear death as children fear to go in the dark; and as that natural fear in children is increased by tales, so is the other.

—*FRANCIS BACON,*
English philosopher

Some who have a near-death experience (NDE), during surgery, injury, accidents, or otherwise often cite that experience—entirely real to them—as evidence of life after death. This is even more so for those who were momentarily dead on the operating table or who were victims of trauma. It is possible that stimulation of the vagus nerve (which connects the brainstem to the heart and lungs) might result in a patient's genuinely feeling detached from his body.

Researchers acknowledge that the phenomenon is very complex. Some neurologists and psychiatrists believe that NDE may result from a blurred mental state. They also point to the similarity between the common NDE report of "emerging from a dark tunnel into the light" and a newborn's journey up the birth canal into the gut of the delivery room. Could this be a replay of that moment?

When you are born, you cry, and the world rejoices. When you die, you rejoice, and the world cries.

—*TIBETAN BUDDHIST SAYING*

* * *

SOME DAY WE'LL KNOW FOR SURE

But if experience is any guide, we still won't be able to let others know. Let's leave it at that.

I am ready to meet my Maker. Whether my Maker is prepared for the great ordeal of meeting me is another matter.

—SIR WINSTON CHURCHILL,
British statesman

20 THINGS YOU DIDN'T KNOW ABOUT DUCT TAPE

THE MAGICAL TOOL YOU JUST UNROLL AND RIP

Wow! Yay! It just might be the most useful tool ever wound onto a roll. Here are a few of its apparently endless uses: sealing, masking, joining, marking, holding, splicing, labeling, protecting, bundling, reinforcing, moisture proofing, wrapping, patching, mending, hemming, refastening . . .

. . . not to mention creating cleavage, preventing frostbite, repairing horses' hooves, supporting weak joints. And—on the darker side—binding and gagging captives, because it is more effective and much easier to manipulate than either rope or rags.

It's duct tape, and wait 'til you see how cool it is.

Ever since the pre-dawn of civilization, primates have sought ways to stick things together. In nature we discovered some substances that are naturally stickier than others. It was a start. It took millennia to figure out how to extract, combine, and apply naturally sticky substances in ways that satisfied. It was probably a pretty stinky process, since so many ancient adhesives were based on animal or fish by-products. On a parallel course, humanity was learning to braid ropes and weave fabrics. Eventually, some early fastening genius figured out how to combine one branch of binding

knowledge with the other, and the earliest ancestors of duct tape were with us, awaiting only the invention of the duct.

There is evidence that Sumerians, Greeks, Egyptians, Chinese, Mesoamericans, and others used adhesives for many years B.C. for domestic, structural, and military purposes.

Enough about them. Fast forward to more historical times. Glues and tapes marched bravely on, used for better or for worse as technology, industry, and the tools of war (i.e., society) developed over the past two centuries.

* * *

1. MACGUYVER'S INSPIRATION. In the 1920s, Richard Drew of Minnesota Mining & Manufacturing invented the first masking tape. Many subsequent advances in tape were sparked by modern business and warfare and the need for fast, secure packaging and bandaging.

A local Minnesota boy who began as a lowly lab tech, Drew's early work was on easily removable masking tape for auto body painters. He moved on to develop more advanced products, including adhesive-coated cellophane and fabric tapes that 3M produced in the 1930s. He patented about 30 products or processes.

2. DUCT OR DUCK? The original name for duct tape was, in fact, duck. Early in World War II, the U.S. military commissioned Johnson & Johnson—remember Band-Aids?—to create a strong adhesive tape to keep ammo cases dry. It was also useful for maintaining vehicles and weapons, securing equipment, and much more. Since it was both waterproof and

green, GIs called it "duck" tape (water rolls off a duck's back).

During the post-war housing boom, builders discovered that the tape was useful for joining heating and air conditioning ducts. The color changed from army green to the silvery color we know today, and people started to refer to it as duct tape. Either name is appropriate, because the mispronunciation "duck tape" (leaving off the final "t" in "duct") was so widespread that the manufacturer trademarked the brand name "Duck." Today, Duck® brand Tape is manufactured by Henkel Consumer Adhesives.

3. LIKE LASAGNA YOU CAN'T EAT. Duct tape consists of three layers. The top layer is a polyethelene, the middle layer is fabric mesh, and the bottom layer is rubber-based adhesive. Doubled over, it's strong enough to pull a 2,000 pound car. Yet, it can be easily ripped into desired lengths with your bare hands.

The different grades of duct tape are based on its thickness. The adhesive layer ranges from 7.5 to 12 mils (one mil equals 1/1,000 inch). The tape with a thickness of 12 mils of adhesive has 60% more glue.

Duct tape is the Rodney Dangerfield of great twentieth-century inventions.

—*TOM POON*, Daily Egyptian,
University of Southern Illinois,

4. DUCT FEAT. In the non-anatomical sense, a duct is a metallic or plastic tube or conduit designed to move liquids, air,

or other gases from one place to another (as in air conditioning and heating). Since ducting usually needs to negotiate bends and even right-angle turns, it comes in jointed sections, which must be tightly sealed to contain whatever is moving through them.

5. YEAH, BUT OTHER THAN THAT, IT'S TERRIFIC. According to Max Sherman of the Lawrence Berkeley National Laboratory, fabric-based tapes with rubber-based adhesives are effective for repairing nearly anything except ducts!

Under high temperature and pressure, duct tape leaks, buckles, loosens, or comes unglued—literally and figuratively! Bummer.

For four months in 1998, the Lawrence Berkeley National Laboratory tested 20 different kinds of duct sealers, ranging from foil-backed tapes to clear tapes and the infamous duct tape. At temperatures typical of most home heating systems, the duct tape fell off in 3 days.

6. OKAY, SO IT'S NOT PERFECT. Duct tape's zillion uses are limited only by human ingenuity and circumstance. It is extremely strong, resilient, adaptable, and user-friendly—easily ripped by hand, no cutting tools necessary. But it is not a long-term solution for most problems, and tapes are rated for strength but not for durability.

One only needs two tools in life: WD-40 to make things go, and duct tape to make them stop.

—G. M. WEILACHER, U.S. writer

7. BY ANY OTHER NAME. Duct tape is gaffer's tape in the movie and TV world. Its uses include holding down lighting equipment, set pieces, props, cables, and even out-of-control actors. Gaffer's tape is typically dull black to prevent unwanted glare or reflections, and it is backed by a less tacky adhesive that won't leave a residue.

Each profession has its own name for the same product. It's rock 'n' roll tape to band roadies on tour. Pit crews on the racing circuit call it 200 mph tape. When the Navy uses it to repair radomes (domes over radar antennae, nose cones on supersonic fighters), it's 1,000 mph tape, designed to be invisible to enemy radar.

Green missile tape is used by aerospace engineers to route and secure wiring and cables on test missiles. For arctic explorers like Norman Vaughn, it's 1,000 mile tape, wrapped on dog sled runners to prevent ice build-up for 1,000 mile treks. Vaughan recommends sleeping with the tape to keep the adhesive pliable in sub-zero climates. Now *that* is loving your product.

As if there weren't already enough nicknames for duct tape! Few canoeists paddle away without a roll of canoeists' companion for instant patching of hull damage. Wisconsin pewter on a roll: Ask Packer fans what keeps that cheese on their heads in the wind. Minnesota (or other rust-producing state) chrome: In the land of lakes, snow, road salt, and rusting cars, applying duct tape is quicker than a trip to the body shop. Hikers' helper: along with a good sleeping bag, a Swiss Army knife, and dry matches, duct tape keeps the great outdoors great fun.

8. HEY, LET'S GET JIGGY WITH THIS STUFF. Amy Smith, winner of a MacArthur Foundation genius award, inspired by kudos for her improvised duct-tape laptop case, has set up a duct-tape design competition for MIT and other local students. Among the ingenious submissions are wallets, suits of armor, sculptures, and a dragon. Prizes are . . . rolls of duct tape.

And the uses keep on coming. Snowmobilers apply duct tape across their noses to fight frostbite and sunburn. After its initial use with ammunition cases, the Air Force used duct tape to cover gun ports on planes to cut down the air friction during takeoff. A Canadian inventor used 7,000 feet of duct tape to make an unproven anti-bear suit. Perhaps he should first see if it's an effective anti-weasel suit or something else less lethal.

9. RUNNING LOW ON SURGICAL TAPE? Some emergency medical technician (paramedic) handbooks suggest using duct tape to close gunshot wounds. It was also used recently at the Columbus Zoo to shut the pouch of a kangaroo whose joey kept crawling out.

In some quarters, duct tape is elevated to the status of plastic surgeon on a roll. It pulls skin tight, lifts, and separates (making it a wonderful cleavage enhancer). And remember—it's also a first aid kit on a roll—a great emergency substitute for splints, bandages, tourniquets, and sutures.

WARTS AND ALMOST ALL. There is evidence that duct tape may help cure warts. Experiments in 2002 at an Army medical center in Tacoma

matched the sticky tape against cryotherapy (freezing with liquid nitrogen). One group of patients taped their warts for six days. On the seventh day, 85% of the warts were gone, compared with only 65% of the cryotherapy group.

But wait. A Dutch study claims that duct tape has little therapeutic value. Maastricht University researchers found it to be only marginally better than ordinary corn plasters in a test of over 100 children aged 4–12. The taped subjects reported post-treatment rashes and itching. None of the children using corn plasters did.

10. THE GREAT OUTDOORS, ENHANCED. Stretching duct tape between trees can provide a quick, easily removable clothesline in a campsite, a volleyball net at a picnic, a territory marker for those who are so inclined. Also, you can mark hiking trails to make it easier to find your way back to the campsite.

Honey, the dog is whining to go out. You've misplaced the leash. But nobody misplaces duct tape. Just stick some tape around Biffie's collar, unroll what you need for your makeshift leash, and wrap the other end around your hand. But don't forget the plastic bag and paper towel—duct tape can't do everything.

TRUE BIT. In September 2003, a hunter in Alaska was attacked by a bear and used duct tape to bind his bite wounds. He then rode an ATV to his pickup truck and drove himself to a hospital.

When the going gets tough, the tough use duct tape.

—Slogan on T-shirt

11. PLANET OF THE TAPES. Avon, Ohio, is the duct tape capital of the world. Duct tape is manufactured there by the Henkel Consumer Adhesives Company, which hosts the annual Avon Heritage Duct Tape Festival on Father's Day weekend and presents the coveted Duct Tape Dad of the Year. Their best customer is tape-happy Springfield, Missouri. More duct tape is sold there per capita than in any other place in the world.

The 2006 Duct Tape Dad of the Year Contest was not limited to Avon, Ohio. Children 7 and over nationwide were invited to describe their fathers' inventiveness with duct tape—why he should be Duck® Tape Dad of the Year. Grand prize: a trip for 4 to the Third Annual Avon Heritage Duct Tape Festival, a mere 25 minutes west of Cleveland. Rides, games, food, and exhibitions of creative duct tape artwork and fashion statements. First place: $500 in cash, a duct tape crown and scepter, a year's supply of duct tape, and the honor of riding on the Duck brand float in their annual parade.

[Duct tape] is very much an American icon, but it's not widely known in consumer channels outside the United States. If you go into Europe and say, "I need duct tape," you'd get blank stares.

BILL KAHL, executive vice president of marketing for Henkel Consumer Adhesives

12. TAKE A DEEP BREATH AND READ THIS DOOZY. In 2003, with the terror alert at Level Orange, U.S. Fire Administrator David Paulison recommended that Americans go out and buy duct tape to seal their windows against possible biological, chemical, or radiological attacks. He did not specify which of the 20+ colors of duct tape to use.

This strikes older citizens as reminiscent of the pointless (mainly placebo) "duck and cover" drills school kids were taught in the early 1950s to defend against those nasty Soviet A-bombs! Even assuming that your duct tape and plastic sheeting would make a perfect seal everywhere—which it doesn't always (just ask your air conditioning people)—sealing your rooms tightly enough to keep out the poison gas would also keep out the oxygen you need to stay alive.

On another practical note—how could you be sure when the attack was starting and when it was over?

13. DEPARTMENT OF CLOSE CALLS. Duct tape was used for emergency repairs on the hair-raising *Apollo 13* mission. It was an improvised engineering assist from Houston that converted a CO_2 filter and allowed the astronauts to breathe during the flight back to Earth in the damaged spacecraft.

One thing a Southern boy will never say is "I don't think duct tape will fix it."

—*ED SMYLIE, NASA engineer who designed the lifesaving cardboard and duct tape contraption for* Apollo 13

14. THE DARK SIDE OF THE DUCT. Just like firearms and accordions, duct tape can be used for evil as well as good. There are crimes in which duct tape is a restraining device, and sometimes even a murder weapon: suffocation or strangulation. We know of no cases of suicide by duct tape.

A 21-year veteran teacher in Missouri used duct tape to cover the mouth of a rambunctious student. Pest control workers in Pensacola trapped and wrapped a rampaging 6-foot emu in a blanket and duct tape. The parents of a 9-year-old boy were convicted of suffocating their son after his head was wrapped in duct tape as punishment for swiping food without permission. A Texas judge ordered court deputies to tape a defendant's mouth shut after his repeated courtroom outbursts.

15. DUCT TAPE ON THE MOVE. Among many uses for duct tape out of the home or lab is this advice for travelers. "Brand" your luggage with brightly colored strips of tape to make it instantly recognizable on the baggage carrousel. You can also wrap older suitcases so they don't pop open in transit while discouraging tampering (duct tape is a pain to mess with).

Right now, on a store shelf near you: "new, improved" flat packaging for duct tape that fits nicely into suitcases, briefcases, or even backpacks. Now travelers and business people can enjoy the conveniences of duct tape without shlepping that clunky roll.

Repair a broken handle or make an informal one, secure stacked valises, devise a luggage pull, protect scraped surfaces. And for spottability, it's hard to beat gleaming tape stripes in bright yellow, orange, silver, green, or pink.

16. LIVE ON TAPE. Nearly $100 million is annually spent on duct tape. In 2005, Henkel sold enough duct tape to wrap the Earth 20 times. There are almost as many statistics about duct tape as there are anecdotes.

In 2001, the amount of duct tape sold could reach from the bottom to the top of the Empire State Building more than 45 million times, round the bases of a major league ballpark 18,257,719 times, span the length of the Great Wall of China 889 times, cross the Golden Gate Bridge more than 15 million times—not paying the toll. The duct tape sold in an average year could stretch to the moon 1.2 times and circle the equator 12.3 times. Who knows? Maybe it's worth a try.

17. UH-OH. WE FORGOT THE TANG. But a roll of duct tape does go up on each NASA flight. And it's a good thing. Duct tape was used on *Apollo 17* to repair the fenders on the lunar rover to protect them and its gear from being clogged with lunar dust.

In 2006, astronaut Peirs Sellers used sticky tape to fix his safety-jet backpack (his SAFER) after it almost came loose during spacewalks while he was repairing the International Space Station. That particular tape, Kapton (made by DuPont), can withstand temperatures in excess of 500 degrees Fahrenheit for over 1 hour.

On the International Space Station, in 2001, astronaut Bill Shepherd was frustrated that there was no table for meals. So he built one with the help of two Russian cosmonauts, Yuri Gidzenk and Sergei Krikalev. They took several pieces of aluminum, bolted them together, and wove a tabletop out of duct tape. Now about the crockery . . .

18. PLANNING AHEAD. If an astronaut on a space mission becomes suicidal or psychotic, NASA policy allows the use of duct tape to bind the deranged person's wrists and ankles,

secure him with a bungee cord, then inject the "patient" with tranquilizers.

This policy raises many issues concerning involuntary treatment, restraint of freedom, possibly even assault. On the other hand, those concerned will certainly be way out beyond the 3-mile limit, therefore not subject to U.S. law anyway. Forget we mentioned it.

19. NOW IF WE JUST HAD SOMETHING BIG ENOUGH TO WRAP IT AROUND. The world's largest roll of duct tape was produced in Hickory, NC, for manufacturer Henkel Consumer Adhesives. Made in 2005, it weighs 650 pounds and unrolls to 5.9 miles long, 3.78 inches wide, and 64 inches in diameter.

Not everyone is handy enough to use duct tape, despite its simplicity. Many people, except in emergencies, follow the traditional American habit of simply buying a new whatever, rather than fixing the old one.

Should you find yourself in a chronically leaking boat, energy devoted to changing vessels is likely to be more productive than energy devoted to patching leaks.

—WARREN BUFFETT,
U.S. businessman

Remember, Wal-Mart sells boats, too, as well as duct tape.

20. MAKE THE ORKIN MAN OBSOLETE. Place duct tape over a drain to trap moth and hump-backed flies that are breeding. Lay strips on the floor to catch cockroaches and crickets! Or

wrap a baby's bottle in duct tape, put flour in the bottle, and place it where the pest of your choice is active. They will crawl up the bottle, and fall in.

Not comfortable with insect visitors? Seal your windows to keep clover mites, springtails, and silverfish out of your house.

* * *

WHERE WILL DUCT TAPE WIND UP?

As is obvious from the above—only a dinky sample of the uses invented for duct tape—possibilities loom endlessly ahead. So long as things need quick fixes and need to be held together—possibly as long as there is physical matter as we know it—duct tape will continue to be an important informal tool in every handyperson's tool kit, closet, or backpack. There is every likelihood, in fact, that it will be an essential part of everyday life when humankind leapfrogs into our next evolutionary stage on other worlds. Things will probably need sticking together on Mars and elsewhere.

20 THINGS YOU DIDN'T KNOW ABOUT GERMS

Get that finger out of your ear . . . you don't know where that finger has been!"

—*ROBERT STACK as Rex Kramer*
in Airplane!

IT'S A MICROSCOPIC WORLD AFTER ALL

They're crawling all over you at this very minute—millions upon millions of them. And you can't brush them off. They're on your hands, too. Millions more are on your chair, your table, and your clothes, but you can't see them. Come to that, they're also swimming in the moisture in your eyes. Your body is swarming with them. They fill your gut and every organ.

They're popularly called germs, and they come in countless varieties.

But before you get totally creeped out, know this: most bacteria are actually good for you. They make it possible for you to digest food. They fight off viruses and other bad things.

And only about 1% of all bacteria cause disease in humans.

But that still leaves a great many varieties of microbes—horrible stuff like HIV, bubonic plague, Ebola, SARS, and others

whose names you probably know. Still, what you don't know about microbes could fill a book. We'll confine it here to just a few pages.

* * *

1. BIG TROUBLE CAN COME IN SMALL PACKAGES. Microbes are tiny (from the Greek *mikros*, "small") organisms that have adapted themselves to live virtually everywhere on Earth. They come in the form of bacteria and fungi (plant life), protozoa (animal life), and viruses (a form of DNA life). Some cause infections and disease, but others are wonderfully useful to humans and others. So keep an open mind.

Bacteria are among the oldest living things on Earth. Fossil records show evidence of bacteria from more than 3.5 billion years ago. Like other life forms, they evolve and adapt. Many microbes have developed ways to resist drugs that once killed them. Adding to human misery: since the mid-1970s, microbiologists have identified at least 30 previously unknown pathogens, including some "superbugs" (more about them elsewhere). Environmental changes and easy international travel have brought more humans into contact with more germs than ever before—and we have no built-in immunity against many of them.

2. HEY—WHAT'RE THOSE LITTLE WIGGLIES? Bacteria were discovered in 1675 by Antony van Leeuwenhoek. But it wasn't until 1848 that Ignaz Fulop Semmelweis made the connection between the wee critters and disease, realizing that simple hand-washing could prevent the spread of infections.

MILESTONES OF MICROBIOLOGY

1857: Louis Pasteur presents germ theory of disease.
1867: Joseph Lister shows connection between microbes and disease, introduces use of antiseptics in surgery.
1876: Robert Koch studies anthrax, proves connection between bacteria and illness.
1928: Alexander Fleming discovers penicillin, and the age of antibiotics begins.

For the first half of geological time our ancestors were bacteria. Most creatures still are bacteria, and each one of our trillions of cells is a colony of bacteria.

—*RICHARD DAWKINS,*
British scientist

3. PUT IT IN PERSPECTIVE. Enlarge the average virus to the size of a baseball, and the average bacterium would be the size of the pitcher's mound. And any one of your cells is the size of the entire ballpark. Viruses and bacteria can live anywhere from 20 minutes to 2 hours on surfaces. Bacteria can grow and divide every 20 minutes. They're faster than bunnies, with fewer moving parts. One single cell of bacteria can become more than 8 million cells in less than 24 hours. Bacteria are so small that 1,000 lined up can fit on the eraser of a pencil.

Think of the earth as a living organism that is being attacked by billions of bacteria whose numbers double every 40 years. Either the host dies, or the virus dies, or both die.

—*GORE VIDAL, U.S. novelist*

4. COLD FACTS. According to a study by University of Michigan researchers in the *Archives of Internal Medicine*, adults typically catch two to four colds a year, while kids get six to ten, resulting in 180 million missed student-days in our schools.

The annual economic impact of colds on lost productivity and doctor visits is $40 billion. Doctors are visited by cold sufferers 100 million times, and more than $1 billion is spent by cold sufferers on antibiotics. But know this: colds are not bacterial; they're viral. And antibiotics have absolutely no effect on viral illnesses.

The CDC reports that more than 36,000 people in the U.S. die every year from the flu, and another 120,000 are hospitalized with flu symptoms.

Support bacteria. They're the only culture some people have.

—DAVE BARRY, U.S. humorist

The "Spanish flu" epidemic of 1918–1919 wasn't of Spanish origin. But somebody had to be blamed. According to historian John M. Barry, the influenza virus probably originated in Kansas. Spreading rapidly across the world, it is estimated to have killed 50 million people, making it the deadliest epidemic ever. Proportionally speaking, based on current world population, that death toll today would be around 170 million!

5. WHERE TO GET YOUR GERMS. The four main germ transmission points are handling pets, coughing, sneezing, and visiting the toilet. A study conducted by the University of

Arizona revealed that the average American office cubicle is the most germ-infested area most people are likely to visit on a given day.

ELAINE

(Leaving the room after rubbing Peggy's keyboard on her butt, sticking the stapler in her armpit, and coughing on her doorknob):

"Oh. All right. You think I've got germs? I'll give you some germs. How about some for your keyboard, huh? Huh? Oooh, how about for your stapler. Hmmm? That's good, isn't it? You have a happy and a healthy."

—SEINFELD, *episode 165, "The Apology," December 11, 1997*

On average, 21,000 germs per square inch are just on your desk—400 times more than on the misperceived office toilet seat. Telephones have as many as 25,000 microbes per square inch, keyboards more than 3,000, and computer mice over 1,500. Toilet seat: about 50.

A toilet handle, however, can have as many as 80,000 bacteria per square inch.

6. HAVE A NICE DAY. A 4-year study conducted by the University of Arizona's Environmental Research Lab (sponsored by Clorox) found shopping carts to be like petri dishes, slobbered with mucus, urine, human saliva, fecal matter, and blood from raw meat. New Jersey and Arkansas have pioneered laws to force supermarkets to offer shoppers free sanitary wipes.

Swabs from 36 shopping carts from four cities (San Francisco, Chicago, Tucson, and Tampa) showed them to be the third nastiest public item people frequently touch. Playground equipment and public transportation armrests were on the top of the list.

In April 2007, a nasty rumor spread like a virus over the Internet that Hispanics were infecting the shopping carts in Guntersville, Alabama, with staph infections. The diseases of hatred and prejudice are as cruel as physical ailments.

7. ARSENALS OF ANTISEPSIS. HYSO, an acronym for "happy hands" in Cantonese, has been developed by Simon Sassoon, nephew of hair whiz Vidal Sassoon. Priced at a mere $60, this device is designed to spray hospital-grade disinfectant on your office doorknobs every 15 minutes. But does it blow dry?

Other anti-germ gadgets include:

SanitGrasp (developed by Fulkerson in Cumming, Georgia) is a large U-shaped device that allows public restroom users to open doors with their forearms, avoiding microbe-laden doorknobs.

The Sani-Shopping Cover was invented by Sandra Barbor of Sandwich, Illinois. For only $3.49, this strip of protective vinyl will cover your shopping cart handle.

SteriPEN, available since 2001, is an ultraviolet device for disinfecting drinking water.

The Foot Flush was created after a study revealed that more than 80 million Americans step on a toilet handle to avoid contact with germs. It's designed to support nearly 1 million flushes: approximately 10 years for a family of five.

The Handler is a rubber and plastic hook that not only opens doors but kills 98% of the germs on them.

The Halo UVX ultraviolet vacuum cleaner emits ultraviolet radiation that kills dust mites, mold, bacteria, and flu virus. The light deactivates the DNA of the creatures, destroying their ability to multiply.

Someone with an exaggerated fear of microbes is technically a mysophobe. To us, it's just germophobe. Famous germophobes—other than fictional TV detective Adrian Monk—include everyone from comic Howie Mandel to the late zillionaire Howard Hughes, the eccentric recluse who refused to shake anyone's hand and insisted on having all objects passed to him swathed in an antiseptic tissue. Donald Trump also refuses to shake hands because of germs. Does he refuse to touch filthy money?

8. LETHAL CONTACT. A 2007 study by the Association for Professionals in Infection Control and Epidemiology reported that methicillin-resistant *Staphylococcus aureus*, commonly called the MRSA superbug, a potentially lethal drug-resistant staph germ, is at an all-time high in our hospitals. It may be infecting patients at about 10 times the rate previously estimated. Some 30,000 U.S. hospital patients may have the "superbug" at any given time. The "superbug" appears immune to antibiotics.

The potentially fatal germ is spread by touch and causes dreadful skin infections. It is typically found among patients being treated for open wounds. Frighteningly, it appears to have become community-associated, breaking out in prisons, in schools, and even among athletes, presumably spreading through skin contact or shared towels or shower shoes.

The germ is still under study, but estimates suggest that it is as much as 10 times more common than earlier studies concluded—and far more dangerous. It can be controlled by only one antibiotic and is rapidly developing immunity to it because of the enthusiastic over-prescribing of antibiotics for the past half century. Indeed, all antibiotics now risk becoming useless in a very few years.

Germs spread in many ways. About 80% of all infectious diseases are spread by direct or indirect human contact (handshakes, kissing, sex). Other pathways are touching something contaminated (often with fecal matter), then thoughtlessly putting your hand to your mouth; inhaling droplets of a sneeze or cough; sharing personal items like towels, combs, and needles; and insect or animal bites.

Gradually becoming aware of this, society has taken countermeasures. During the U.S. flu epidemic of 1918, the town of Prescott, Arizona, outlawed handshaking. More recently, during a 2004 flu outbreak, the Roman Catholic Diocese of Metuchen, New Jersey, gave parishioners the option to smile, bow, or wave instead of shaking hands during the Sign of Peace part of the Mass.

Cautious scientists have started using an "elbow bump" instead of a handclasp when working in the field.

9. WE'RE NOT REALLY VERY CLEAN. A 2005 study by the American Society of Microbiology reports that 91% of adults claimed they washed their hands after using public toilets. Even fewer washed their hands after using their own bathrooms! And 53% of all people don't wash their hands properly after sneezing or coughing, with 22% failing to wash

their hands after handling animals. Experts say effective hand washing time is 20 seconds, about as long as it takes to sing "Happy Birthday" twice.

A nationwide survey in 2005 by the American Society for Microbiology and the Soap and Detergent Association revealed that 25% of men don't wash their hands after using a public bathroom. Only 10% of women don't.

10. POPULAR GERM MYTHS DEBUNKED. Antibacterial soap may be all washed up. The Centers for Disease Control and Proctor & Gamble sent test families in Pakistan either ordinary soap or antibacterial soap to determine the effect of hand washing on diarrhea and acute respiratory diseases. Their conclusion: "The incidence of disease did not differ significantly between households given plain soap versus antibacterial soap." Uh-oh.

Also, alcohol-based mouthwashes may not kill germs that cause bad breath because the alcohol dries out the mouth. There's not enough saliva to help wash away any bad breath bacteria. (Bad breath is caused by food stuck between your teeth and the accumulation of bacteria on the back of your tongue.)

Breathing recycled air on airplanes is not what makes passengers sick. It's inhaling the effluvia from seatmates who spew mucus droplets when they cough, sneeze, or even yawn.

11. IS IT SOUP YET? The kitchen is the dirtiest room in your house. The innocent-looking cutting board has roughly 200% more fecal bacteria than your toilet seat. The dishrag is usually the dirtiest article in your house, since it sops up

gunk from countertops that include uncooked bacteria-infested food. A used sponge harbors millions of bacteria, including notorious *E. coli*, *Salmonella*, and *Campylobacter*. To kill off these disease-inducing bacteria, wet and then place your sponge in the microwave for 2 minutes.

The Hygiene Council in Britain found that public toilets in the U.K. are cleaner than kitchens at home. (See above.) And your office is gukky: on average, there are about 400 times more bacteria on your desktop than on a toilet seat. Here's more oddness for germ trivia fans:

Vacuum cleaner bags are germ-laden and should be changed monthly; they pick up and spew household mites and microbes from room to room.

Washing your underwear with the rest of your clothing can cause hepatitis A and stomach flu from the fecal-borne organisms that burrow into clothing even during washing.

Despite what the rubber industry says, wooden cutting boards may be more sanitary because wood absorbs bacteria but does not release it.

Telephones and elevator buttons often house colonies of *Staphylococcus* ("staph"), which causes skin infections and meningitis.

Your computer mouse is probably swarming with *E. coli*, which can cause many diseases from diarrhea to kidney problems.

12. GERMS ON THE GO. A 2006 test found that tens of millions of *E. coli* bacteria were found on toilet seats on Greyhound buses. Amtrak didn't fare much better—coliform bacteria by the millions covered their bathroom sink handles. This bacterium signals fecal contamination. The armrests in

Amtrak café cars had high levels of MSRA, which causes skin infections.

But they're doing their best. Greyhound brings in their buses every 180 days for an 8-hour cleaning that includes steam cleaning seats, rewaxing floors, and treating the toilets with a powerful antibacterial solution. New York City subway cars have routine maintenance every 66 days or 10,000 miles, and they are thoroughly cleaned from floor to light lenses.

More filth in motion: a swab test by microbiologist Dr. Philip Tierno, author of *The Secret Life of Germs*, found—perhaps unsurprisingly—fecal organisms in a New York City taxicab. The organisms included *Klebsiella*, *Enterobacter*, and the ever-popular *enterococci*. Wonder where they were headed?

13. DOO-DOO DO'S AND DON'TS. Close your toilet when flushing. Depending on the age of the toilet, soiled water can spray a mist of excrement up to 20 feet from the bowl. Not an appetizing prospect.

We are not without defenses against invading germs.

Each year, there are an estimated 76 million cases of food-borne illnesses in the U.S. and more than 70,000 known cases of food poisoning in the U.K. According to *Consumer Reports,* in 1998, 71% of store-bought chicken contained harmful bacteria. The USDA therefore recommends minimum internal temperatures to kill bacteria in foods. For beefsteak and fish, 145 degrees Fahrenheit. Pork, ground beef, and egg dishes, 160 degrees. Chicken breast, 170 degrees, and whole poultry, 180 degrees. Like your meat rare? Sorry.

Change your bed sheets weekly. Dust mites flake off your skin cells and cause allergies. Also, in 10 years the weight of your mattress increases because of the buildup of dust, pet dander, hair, and bodily fluids.

Children should get their first immunizations before they are 2 months old. Adults need tetanus and diphtheria boosters every 10 years.

The hand sanitizer Purell claims to kill 99.9% of most common germs that cause illness in as little as 15 seconds. The other 0.1% must be tough little guys.

14. GERMS GET IN YOUR EYES. Sharing mascara can cause conjunctivitis. Adding tap water or saliva to mascara just helps harmful bugs breed better. Storing it in temperatures above 85 degrees will cause bacteria to incubate. Mascara should be replaced after 3 months—the time it takes for significant bacterial growth, which can lead to eye infections. If it smells odd or is discolored, chuck it.

Men are like mascara; they run at the slightest display of emotion.
—KABIR BEDI, Indian actress

15. PAPER TOWEL, ANYONE? Despite its hygienic pretensions, don't use the hand dryer in a public restroom. They're there mainly because they are more cost effective than paper towels. Your hands are actually getting dirtier because the air blown on your hands is the same air whirling around that microbe-filled bathroom.

There was a bunch of girls giggling, standing by the door of the restroom, when I was there. They wanted my autograph. I thought they should let me wash my hands first.

—*CARMEN ELECTRA, U.S. actress*

16. PASS THE MOUTHWASH. Every mouthful of ocean water contains over 1,000 different species of bacteria and dozens of microscopic life forms like diatoms, planktonic foraminifera, viruses, microscopic worms, algae, and larvae.

The capacity to blunder slightly is the real marvel of DNA. Without this special attribute, we would still be anaerobic bacteria and there would be no music.

—*LEWIS THOMAS, British scientist*

17. GOOD GERMS IN ACTION. *Lactobacillus acidophilus* is a friendly bacterium that inhabits your intestines and helps you digest food, destroys many disease-causing organisms, and actually provides nutrients for your body. It's an essential ingredient in yogurt, sauerkraut, and cheese. If you ate any of those today, thank a bacterium.

White tea has proved more effective than green tea against bacterial viruses. White tea extract in toothpaste rids your mouth of pathogens.

Strange bedfellows: researchers have recently discovered that the herpes simplex virus may possibly protect you against the bubonic plague and other bacterial contagions.

18. COINCIDENCE? Doctors can't prove a link, but suspicions abound that unclean public yoga mats are now causing skin

infections. According to *Yoga Journal*, 16.5 million people practiced yoga in the United States in 2005, up 43% from 2002. Since then there's reportedly been a steady increase in reported cases of jock itch, plantar warts, and staph infections among yoga practitioners.

Yoga teaches us to cure what need not be endured and endure what cannot be cured.

—B.K.S. IYENGAR, Indian yoga master

Happiness is having a scratch for every itch.

—OGDEN NASH, U.S. poet

19. DEFENSE MECHANISM. Your gut, which is home to 750 trillion bacteria and archaea, contains gut flora, which help the immune system ward off more dangerous bugs. These flora have the ability to break down nutrients and manipulate how the body stores fat.

Infants who are breast-fed have large amounts of bifidobacteria in their intestines, yet have fewer intestinal upsets. We don't know why.

20. THE FIVE-SECOND RULE. If you pick something up within 5 seconds, it's still clean enough to eat. Really? In 2003, a high-school intern at the University of Illinois tested this theory by contaminating ceramic tiles with *E. coli*, then placing gummy bears and cookies on the tiles for five seconds. All the food became contaminated with bacteria.

Another 5-second wonder: A team at Clemson University conducted tests by dropping bread and bologna on

Salmonella-laced tile, wood flooring, and nylon carpet. Hundreds of the *Salmonella* bacteria remained alive for 28 days! The surfaces had been contaminated for 8 hours, so the food picked up 8,000 bacteria after only 5 seconds. Left for 60 seconds, about 10 times the bacteria was recorded.

The lesson: if you tend to drop food, develop faster pickup skills.

* * *

WHITHER GERMS?

There is increasing concern not only about dangerous microbes traveling from disease "hot spots" around the world but also about possible contamination from outer space. Already (see chapter on Aliens), there is suspicion that microbes from elsewhere may be bombarding the Earth in great quantities. We are very likely as unable to combat these organisms as the Native Americans were unprepared for diseases delivered to these shores by European conquerors and colonizers. (It is now increasingly accepted that the original population of the Americas was far greater than earlier history books record—that some areas may have lost up to 90% of the indigenous populations with the arrival of white men. Could such a disaster be in store for our entire planet with the arrival of little green men?

As it is, the R&D departments of pharmaceutical companies are working in tandem with epidemiologists to try to anticipate and counter the germs of the future. Some companies are developing anti-microbe appliances and marketing disposable respirator masks to help people resist airborne infections such as SARS.

20 THINGS YOU DIDN'T KNOW ABOUT THE INTERNET

Oh, so they have the Internet on computers now!

—*HOMER SIMPSON*, The Simpsons

(episode 192, "Das Bus," February 15, 1998)

COUCH POTATOES AT THE SPEED OF LIGHT

The Internet is the ultimate enabler.

It enables us to buy and sell anything from houses to automobiles to celebrity memorabilia to pieces of Martian rock (see chapter on Meteors); to shop for groceries, pay utility bills, make travel arrangements (even print boarding passes); do on-line banking; exchange instant messages with friends in far-away places; gamble for real money; reserve a restaurant table after checking the menu; and enroll in college—even take courses—without ever leaving home.

The Internet is the twenty-first-century coffee house. For untold millions it's a social club and a dating exchange—for some, even a sexual surrogate. It's an entertainment facilitator: rent movies, watch TV, download a million Golden Oldies—without ever leaving home.

In 2005, 95% of Internet users in the U.K., Austria, and Germany made purchases online. One study projects that U.K. shoppers will spend £42 billion in 2007.

The Internet is a worldwide medium for exchanging information and opinions, from wise to wacko. We can read newspapers from distant lands, see our own house from outer space, and watch breaking news unfold in real time via streaming video.

The Internet has upended the balance of power in marketing, enabling consumers to access product information and compare price/value offers. Let your electrons do the walking.

In just two decades, Planet Earth has lit up. The Internet is both cause and effect of growing interconnectivity and convenience.

But it is not only the blazingly fast adoption of new technologies but the convergence and interrelationships among those technologies that is amazing. Personal appliances, increasingly miniaturized for portability, are crammed with more features than ever, enabling the "connected generation" to send and receive e-mail and text messages, share audio and video files, and exchange pictures and real-time video from cell phones and laptops almost anywhere on the planet.

* * *

1. JUST LOOK AT 'EM ALL! There are over 1 billion Internet users worldwide. Unsurprisingly, Asia makes up 56% of the world's Internet usage, with a whopping 398,709,065 people online—more than the total U.S. population of just over 300 million.

The Internet is the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had.

—*ERIC SCHMIDT, Ph.D.,*
chairman and CEO, Google

There are currently over 60 million online blogs, institutional or personal. As of 2007, some 175,000 were cropping up daily—approximately one every 2 seconds! MySpace.com is the most visited Web site on a daily basis. Google's search index is presently over 8 billion pages.

The Internet is a shallow and unreliable electronic repository of dirty pictures, inaccurate rumors, bad spelling, and worse grammar, inhabited largely by people with no demonstrable social skills.

—*AUTHOR UNKNOWN,* The Chronicle of
Higher Education

2. WHEN AL GORE WASN'T LOOKING. Tim Berners-Lee solely invented the World Wide Web in 1991. Within 5 years, the number of Internet users jumped from 600,000 to 40 million. At one point, the number was doubling every 53 days.

In October 2006, the World Wide Web reached 100 million Web sites. (In 1995, Netcraft, an Internet monitoring company in Bath, England, had cataloged only 18,000!) The 50 million milestone was reached in 2004.

According to the U.S. Department of Commerce, it took 38 years for radio to attract 50 million users and 13 years for TV to snare that number—but only 5 years for the Internet.

The expression "cyberspace" was coined in 1982 by science fiction writer William Gibson. "Cyberspace" means a fifth dimension, or virtual meeting place. And so it is. Incidentally, although Al Gore did not single-handedly invent the Internet, he did coin the phrase "information superhighway."

The Internet is the world's largest library. It's just that all the books are on the floor.

—JOHN ALLEN PAULOS, Ph.D., professor of mathematics, Temple University, Philadelphia

Many Web surfers are frustrated by the overwhelming blizzard of content available. It's hard to tell garbage from nutrition, useful information from misinformation. More than one commentator has noted that seeking information online is like trying to get a glass of water from Niagara Falls.

3. WHAT HATH RAY WROUGHT? The world's first e-mail was sent in 1971 by Ray Tomlinson, an engineer at a computer company in Cambridge, Massachusetts. The message read "QWERTYUIOP", which are all the letters on the top row of your keyboard.

Only 9% of Internet traffic is e-mail; 75% is file sharing. Details are available at www.internettrafficreport.com, which monitors and reports worldwide Internet flow. Interested parties can study statistics by continent or country on a 24-hour or weekly basis.

Everyone you know probably uses the Internet or knows someone who does. But few really know what it is.

What is free speech, and what is merely data? What is a free press without paper and ink? What is a "place" in the world without tangible dimensions? How does one protect property that has no physical form and can be infinitely and easily reproduced? Can the history of one's personal business affairs properly belong to someone else? Can anyone morally claim to own knowledge itself?

—*MITCHELL KAPOR, computer developer, and* JOHN PERRY BARLOW, *essayist and former lyricist for the Grateful Dead*

4. YOUR HONOR, MAY I APPROACH THE BENCH? In May 2007, a British judge, presiding over a trial of three men accused of cyberterrorism, was baffled by the term "Web site." "I haven't quite grasped the concepts," said Judge Peter Openshaw. The Internet was being used by violent Islamists to post images of beheadings of Western hostages.

The Internet is a series of tubes.

—*TED STEVENS, U.S. Senator*

5. UHHH, WE'RE NOT NUMBER ONE. American broadband connection is sub-par. The Communications Workers of America say that the average U.S. download speed is only two megabits per second. Japan is 61 megabits; France, 17. And we pay more for our slower speeds. South Korea spends 8 cents per 100 kilobits of bandwith, Japan 7 cents—compared with our whopping 49 cents for the same service. What gives?

6. BEEP BEEP. A simple analogy of bandwidth traffic is highway traffic. Bandwidth is lanes; traffic is cars. The fewer the cars (or packets of information), the faster the flow. Bam. That simple.

Internet traffic consists of the number of bits moving through network connections, usually measured in gigabytes. One gigabyte is 2 to the 30th power—over a billion bytes.

7. HOW MUCH BANDWIDTH IS ENOUGH? Most personal or small business sites don't need more than 1 gigabyte (GB) of bandwidth a month. Simple, fairly static Web pages (as opposed to animated, music, or video-heavy sites) with minimal daily traffic do just fine with low bandwidth plans.

If a site doesn't offer downloads, the formula for calculating the amount of necessary bandwidth is this: average daily visitors × average page views × average page size × 31 × fudge factor. For sites involving downloads: (average daily visitors × average page views × average page size) + (average daily file downloads × average file size) × 31 × fudge factor.

What's a fudge factor? Any number bigger than 1, since nobody can estimate traffic with much certainty, but you want to be able to handle more rather than less. Many sites use a fudge factor of 1.5, or 50% on the long side. And why that 31? Because hosts' monthly charges are usually based on average daily traffic, and most months have 31 days.

Too much of a good thing can be wonderful!

MAE WEST, U.S. actress

8. NAUGHTY, NAUGHTY. Five West Africans were arrested in April 2007 for their connection to the Nigerian 419 scam—a scheme where an e-mail is sent to get people to pay large sums of money in exchange for a share in a non-existent inheritance or lottery prize. A year earlier, Dutch authorities arrested 11 people on similar charges.

Throughout history, crooks have found crooked uses for new technologies and techniques. The emergence of online personal information exchange and credit-card payments has blown open the doors for scamsters and identity thieves. In the brave new twentieth-century world, thieves can pick your pocket or steal your savings at the speed of light from 10,000 miles away.

Researchers project that online fraud could cost businesses over $3 billion by 2010. In 2006, major online retailers fell victim to cybercrime, as did electronic libraries, including the Library of Congress, the British Library, and even the Vatican. Nor are techies safe. In 2000, hackers broke into Yahoo!, Buy.com, eBay, Amazon.com, CNN, and E-Trade, shutting down all incoming traffic.

9. GARBAGE IN, MORE GARBAGE IN. According to Postini, Inc., one of the world's largest spam-filtering companies, there was a 147% increase in unsolicited e-mail between 2005 and 2006. For every welcome e-mail, 14 junk messages flood the in-boxes. On December 18, 2006 (a random day), Postini intercepted 1,010,186,128 spam e-mails.

10. THOSE ENTERPRISING YANKS. About 75% of all spam comes from Internet addresses in the U.S.

Almost as bad as scamming is its cohort and enabler, spamming. The Spamhaus Project, a volunteer task force in London that ferrets out notorious spammers, tracked down Jeanson Ancheta after an intensive 2-year search. Ancheta was sentenced to 5 years for hijacking 400,000 personal computers. According to Spamhaus, six of the world's Top 10 Worst Spammers are in Russia and Ukraine.

Possibly the most hated couple in cyberspace are Laurence Canter and Martha Siegel, who spammed ads for their husband-and-wife law firm, promoting their services for aliens getting a green card. The e-mail was continuously posted on every active bulletin board on the Internet and was seen over and over again by millions of surfers. In response, recipients started sending their own responses. One 16-year-old threatened to visit the law firm and burn it down.

11. SEX SELLS. The domain name porn.com, was recently sold for $9.5 million. The record for the sale of a domain name was sex.com, which was reportedly sold for $12 million in 2005.

According to *Good* magazine, 12% of all Web sites are pornographic (about 372 million Web pages). "Sex" is the most searched word on the Internet. U.S. tax revenue from Internet porn in 2006 was $2.84 billion—and that's just what was reported. Interestingly, about 70% of all internet porn traffic occurs between 9:00 and 5:00 on workdays! Say—has Oglethorpe finished preparing that third-quarter sales report yet?

The difference between pornography and erotica is lighting.

—*GLORIA LEONARD, former porn actress, magazine publisher*

12. A CHILLING EFFECT UNTO DEATH. In June of 2007, Iran's Majlis (Parliament) voted overwhelmingly to pass a bill that could deliver the death penalty to anyone convicted of working in, producing, or even distributing pornographic movies. Such people are referred to in the bill, as in the Muslims' holy Qur'an, as "corruptors of the world" and rank among the most heinous of criminals.

Indictable parties include not only performers and directors but also cameramen and other crewmembers—the "little people." Besides filmmakers, a variety of penalties from prison terms to execution may also apply to distributors, retailers, and producers of Web sites that carry pornographic content.

Iran has established its first female-only Internet café near Tehran, offering veiled ladies high-speed access and free computer lessons. And, of course, no access to porn sites.

13. VIRTUAL ROLL CALL. Countless educational institutions now offer distance learning—vocational training through doctoral programs. Established universities offer online courses. Lesser-known "universities"—some with real as well as virtual classrooms—have thousands of students. Question 1: How do they know who's really reading, writing papers, and

taking exams? Question 2: How seriously should we take their diplomas?

The Internet is increasingly an essential learning tool for teenagers, many of whom never knew a time when students' principal information source was a paper library, not an electron-based library. Besides home use for course work, more classrooms each week are installing Internet connections.

According to a Pew study from 2000, over 70% of students interviewed called the Internet their primary source for major class projects. Some also accessed online study aids like CliffNotes and Sparknotes, and 18% of that sample further reported knowing someone who used the Internet to cheat.

14. DADDY DEAREST. A 10-month-old in Illinois was approved for a gun permit after his father submitted the form online, paid a $5 fee, and submitted a photo of the still toothless infant. Illinois, known for its strict gun control laws, somehow overlooked the age requirements. Dad thinks his son's gun permit "makes an adorable addition to his baby book."

Among many interesting factoids and strange anecdotes related to the Internet:

Seattle is the most "unwired" major city in America—which simply means more wireless broadband access per capita.

A maximum security men's prison in Iowa recently spent $6,000 to change its locks after keys that previously belonged to a former security guard were sold on eBay.

Internet: absolute communication, absolute isolation.

—*PAUL CARVEL, Belgian aphorist*

15. THE DARK SIDE. The Internet has become the number one medium for the interchange of terrorist information, propaganda, and recruitment.

You don't have to go abroad for recruitment and training. You can enlist, chat, commiserate, and, even more significantly, study methods to express your radicalism in acts of violence.

—*RICHARD CANAS, New Jersey Office of Homeland Security and Preparedness*

16. BY GOLLY, IT'S EVERYWHERE. In 2005, online dating revenues exceeded $500 million. Online dating even goes on behind bars. Some of the most popular prisoner Web sites are prisonpenpals.com, inmate.com and ladiesofthepen.com.

Susan Smith, the South Carolina mother who drove her two sons into a lake and left them to drown in 1994, had a personal ad on writeaprison.com that drew an estimated 1,000,000 e-mails and letters. What is that about?

17. EMINENT DOMAINS? The federal government owns 74% of the 4 billion available IP addresses. Meanwhile, China is preparing the next Internet wave, designed to accommodate

340 trillion trillion trillion IP addresses. That's a lot of zeroes, friend.

18. HEY, SOLDIER. Uncle Sam wants you . . . to stop surfing, at least on his computers. The Pentagon has banned access for troops in Iraq and Afghanistan to MySpace, YouTube, Pandora, MTV, iFilm, Hi5, and other video-sharing and music sites. Reason: "security concerns." Oh really.

Among Internet search engines, Google averages 53.7% of all searches, followed by Yahoo!, MSN, and Ask.com.

19. NO THANKS, I'M JUST LOOKING. The first popular Web browser was Mosaic (1992–1997). Since then, web browsers have multiplied, with market dominance (May 2007) going to Microsoft's Internet Explorer (78.67%), followed by Firefox (14.54%), Safari (4.82%), Netscape (0.83%), Opera (0.74%), Opera Mini (0.16%) and Mozilla (0.15%).

Futurist Ray Kurzweil anticipates an Internet breakthrough within the next decade or so that will allow for virtually vertical improvement. Not just faster, but totally transformed. Kurzweil and others expect access no longer to be limited to implements like computers, screens, and videophones but actually to be implanted nearly everywhere, including in people.

Remember, America, I gave you the Internet and I can take it away. Think about it.

—*SEN. AL GORE (joking on the* Late Show with David Letterman, *September 14, 2000)*

They are the monorails of this decade: the wrong technology, totally over-promised, and completely undelivered.

—ANTHONY TOWNSEND, research director at Silicon Valley's Institute for the Future, referring to cities' struggle to get Wi-Fi technology working right

20. ATTACK OF THE INTERNET-BITERS. Most people love the Internet, but it has its detractors—not mindless Luddites, either, but some thoughtful, cyberwise thinkers. Several high-profile commentators point to a blossoming Internet fatigue syndrome, especially since the launch of Worldwide Web 2.

Dissenters are concerned that the unrestricted mushrooming of amateur content may overwhelm professional, responsible media and that too much unreliable information is available, and they fret about the dumbing-down effect on culture caused by so much unintelligent "twittering."

Spend some time on YouTube, drift around the blogosphere . . . listen to some random bands on MySpace. Afterward go read the New York Times, *see a mainstream movie, and wander through a record store, if you can still find one. Then ask yourself which you'd rather have.*

—ANDREW KEEN, British-American author, interview with Wired *magazine*

The Internet is so big, so powerful and pointless, that for some people it is a complete substitute for life.

—ANDREW BROWN, British journalist

* * *

FUTURE OF THE INTERNET

OK, for better or worse, where is the Internet heading? Nobody can offer more than clever suppositions. By definition, we cannot imagine what we cannot imagine.

Gutenberg could never have imagined teenagers in Omaha text-messaging friends in Sydney about a concert in Stockholm.

Cave artists at Lascaux or Altamira could never have imagined the Sistine Chapel ceiling, let alone the clip-art any 10-year-old can import to print greeting cards.

The first conscious users of language could never have imagined a Shakespearian sonnet, Navajo code talkers, or United Nations simultaneous interpreters—among the most brilliant humans who ever used words.

Prehistoric toolmakers with pointed sticks and flint axes could never have imagined astronauts circling far above their heads at thousands of miles an hour, using their own kind of hand tools on a space station.

Of all those who share our planet, only her humankind is truly the toolmaker, the language maker. But let's be modest. Consider that we are merely an upgrade of primitive man—say, *Homo sapiens* 1.6. The Internet has helped to deliver us to the threshold of 2.0, the latest advancement for our species, combining tools with language. Who dares to guess what 3.0 may be—and how soon it may arrive?

Not these writers.

Only one thing seems certain: the Internet is a significant step toward global connectivity. Some think it is evidence that our collective unconscious is rearranging itself into collective consciousness. It's a coming of age, like an insect's transformation from larva to pupa. This may be our opportunity to un-Babel ourselves and create the so-called global village.

Perhaps the Internet is our village campfire, illuminating

the clearing we have made in the dark jungle of ignorance and fear, pushing away the surrounding darkness.

What lies beyond that light remains to be seen.

The Internet debate is becoming animated. Is the Internet becoming mainly a vast clearing house for porn, illiterate blogs, spam, scams, and foul content spewed out by ignorant and malicious people?

People involved in Web 2.0 are in an echo chamber. There isn't a debate, and there isn't a conversation. They're just listening to themselves. I find this incredibly dangerous.

—*ANDREW KEEN, British journalist*

20 THINGS YOU DIDN'T KNOW ABOUT METEORS

There is much more nothing in the universe than anything else.

—ANONYMOUS

We usually think of space as an infinite twinkling emptiness, exploding outward ever since the Big Bang at unimaginable speeds, heading to an unimaginable future in some unimaginable out-thereness.

Matter (physical stuff) constitutes only about 4% of everything out there. And matter consists overwhelmingly of vast empty spaces between atomic particles.

But even teeny bits of stuff were presumably enough to create huge galaxies teeming with other stuff—ranging from microscopic to galactic in size—bashing back and forth across the infinite twinkling emptiness. It is not unreasonable to view space as a cosmic-scaled bumper-car arena, with chunks of matter whooshing around and colliding with anything in their path.

Sometimes Earth is in that path, which increasingly concerns scientists. Impact craters on the moon (easily whacked because it lacks a protective atmosphere) attest to the frequency

of these collisions. And so do the dramatic meteor showers we can see from Earth—"shooting stars" that arc fleetingly across the sky as they incinerate in our upper atmosphere.

But occasionally "rocks from above" are so big that they don't burn up in the atmosphere but make it down to the surface. When that happens, we get souvenirs from outer space—or sometimes the result is the extinction of most of the species on Earth. It's the luck of the draw.

* * *

1. AFTER THE FALL. Each day about 4 billion meteorites fall to Earth. Tons and tons of them. Most are microscopic; some are pebbles. Occasionally one is big enough to dent a roof or leave a crater. Because so much of our planet's surface is ocean, most simply ploosh away unnoticed.

Anywhere on Earth, almost every night, meteors (or meteoroids) can be seen, provided it's dark enough. Every hour "sporadics" streak across the sky. Several times a year, predictable "meteor showers" fill the atmosphere with hundreds or even thousands of flaming trails. They are predictable because each year Earth passes through debris fields left by comets and by other trackable space flotsam.

Meteorites contain the oldest known matter in the solar system, as well as pre-solar grains, minerals, or other stars. These were created perhaps billions of years before our solar system was born.

2. A ROCKY START. Since ancient times, people everywhere have been awed by fire streaking across the sky—signs of things to come, or evidence of angry gods. Some believed

that shooting stars brought good fortune; others saw them as messengers of death or bad luck.

Superstition springs from the unexplainable, the otherworldly. Blazing rocks falling from heaven must have seemed holy to primitive societies. Stones from the sky occupy a place of honor in many cultures—at the Temple of Apollo in Delphi and at many other ancient Greek and Roman holy sites.

Members of certain South American tribes pick up stones to avoid bad luck upon seeing a meteor. Superstitious Filipinos hurry to tie a knot in cloth before a meteor's flare fades. Some Hawaiian Japanese open their kimonos to let in the good luck from an oncoming meteor. Some Americans believed it was bad luck ever to point to, or even talk about, meteors. Meteorites found at Native American burial sites suggest that they were objects of worship.

3. ROCK OF SAGES. Embedded in the wall of Islam's holiest shrine, the Ka'aba at Mecca, is a black stone believed by some to be a meteorite. Although it is not worshipped directly (only God is worthy of worship), Muslim pilgrims treat the rock with reverence. Legend teaches that the stone was found by Abraham and Ishmael when they were looking for stones to construct the Ka'aba.

The passion for things from above is not limited to native societies. The Vatican houses one of the largest meteorite collections known to exist. New York's respected American Museum of Natural History is fighting to hold on to a meteorite claimed by the Kiowa Nation. London's Natural History Museum boasts a collection of some 2,000 meteorites, which the museum began collecting and cataloging in 1802.

I came in with Halley's Comet in 1835. It is coming again next year (1910), and I expect to go out with it. It will be the greatest disappointment of my life if I don't go out with Halley's Comet. The Almighty has said, no doubt: "Now here are these two unaccountable freaks; they came in together, they must go out together."

—MARK TWAIN, U.S. humorist

4. DOUBTING THOMAS. Early meteor studies appeared in the pages of the *American Journal of Science and Arts*, founded in 1818 by Yale College chemistry professor Benjamin Silliman (1779–1864). When Silliman investigated a fallen meteor in Connecticut in 1807, President Thomas Jefferson mocked him for believing in rocks from the sky.

Although a brilliant man and an ardent science hobbyist, Jefferson was also very much a Southerner. He therefore dismissed Silliman's research, scoffing, "I would more easily believe that two Yankee professors would lie than that stones would fall from heaven."

The tradition of partnership between scientists and meteor amateurs dates from 1837, when Professor Denison Olmsted (1791–1859), himself a student of Silliman, invited his Yale College students to join him in monitoring the Leonids.

5. COMING SOON TO A PLANET NEAR YOU. According to cometologist Gene Shoemaker (remember Shoemaker-Levy 9, the comet that blasted Jupiter in 1994?), impact cratering is the most widespread geological process in the solar system. Every solid body we can observe is cratered, so cosmic

bumping seems unavoidable. Any major collision could cause mass extinction, such as the one 65 million years ago that wiped out most earthly species, including dinosaurs, which had existed 1,500 times longer than the human race has!

The universe is not the tranquil place we once thought. Our home within it, the Earth, is vulnerable. The only thing we know for sure is that someday, the Earth will once again be hit by a devastating rock.

—PETER THOMAS, PBS announcer

Take it seriously. But don't pack your bags just yet. Astronomers calculate that a huge rock could obliterate Earth later this afternoon or in another million or two years.

Over the past 500 million years, the planet has suffered not just one but five major mass extinctions. Most of them extinguished an estimated 50% of all species alive at the time. The best known is the Permian-Triassic, which obliterated 90% of all life on the planet 250 million years ago.

In 2004, a 30-foot-wide meteoroid struck the atmosphere over Antarctica and left 2 million pounds of dust in its wake—enough to seed rain clouds and affect the climate on the far side of the planet.

6. DON'T FORGET TO DRESS IN LAYERS. To protect it from the estimated 100,000 meteoroids that will slam into it during its expected 20-year life span, the International Space Station is covered with a foot-thick blanket of Kevlar, the material used to make bulletproof vests. Even very small meteoroids can damage the spacecraft. The Hubble space

telescope has at least 570 tiny pockmarks and chipped surface areas.

7. HIP ACTION. Meteorite impacts have been blamed for hundreds of injuries, but only one has been verified by scientists. In 1954, Annie Hodges of Sylacauga, Alabama, was struck by an 8-pound meteorite that crashed through her roof and bounced off a radio onto her hip while she was napping.

A study published in 1985 in the journal *Nature* calculated the rate of impacts to humans as 0.0055 per year, or one event every 180 years. Thanks to Annie Hodges, the odds are that the rest of us are safe through the end of the twenty-first century.

That may be why President Clinton canceled *Clementine II*, a spacecraft designed specifically to defend Earth against incoming meteoroids, asteroids, and comets (aka Near Earth Objects). Or the probe may have fallen victim to the "giggle factor"—the tendency of government officials to snicker at the perils posed by flying rocks.

8. IMPACTUS INTERRUPTUS. One way of deflecting a Near Earth Object headed our way is to detonate a nuclear device in its vicinity. The resulting radiation pulse would vaporize its surface, delivering a counter-thrust that would (we earnestly hope) throw the body off course. This push is called an X-ray slap.

We're not defenseless if we have enough warning. If we were to spot an asteroid on a collision course decades ahead of time, we could launch a rocket to intercept it. Only a tiny change of velocity—possibly only millimeters a second—would translate into a huge deviation over a trajectory of millions of miles.

I would rather be ashes than dust! I would rather be a superb meteor, every atom of me in magnificent glow, than a sleepy and permanent planet.

—*JACK LONDON, U.S. writer*

Technically, a meteor (from the Greek *meteoron,* meaning "phenomenon in the sky") is merely the streak of light we see trailing a meteoroid. A meteoroid is any interplanetary object bigger than a speck of dust and smaller than an asteroid.

9. QUICK, CALL JERRY LEE LEWIS. Particularly brilliant meteors are colloquially called fireballs and can be quite large, weighing dozens of pounds. But even BB-sized meteors can produce spectacular rooster tails of fire that can persist for minutes. Some fireballs ("bolides") actually explode as they break through the sound barrier. Meteoroids that scream into the atmosphere at 11.2 kilometers a second or more (about 40 times the speed of sound) are melted by the friction. The air they pass through becomes electrically charged, which makes the rock a literal ball of fire. When the fireball blows itself out at impact, a "fusion crust" is left on the meteorite's surface, but the interior is left intact and available for study. This is useful for geologists. They can take meteorites tortured by the superheated atmosphere and compare them with Earth rocks that have been subjected only to slow geological processes.

Viewers polled after a 2006 TV broadcast exploring Earth's final days believed that the world would probably end in one of the following ways:

- Roasted by gamma rays or supernova
- Sucked into a black hole
- Artificial intelligence run amuck
- Cataclysmic eruptions from Earth's molten core
- Asteroid or meteor impact
- Nuclear holocaust
- Pandemic (natural or bioterror)
- Global warming

10. NAME GAME. Meteor showers are named for the part of the sky (the constellation) in which they appear to originate. Hence, the Geminids are from Gemini, Lyrids from Lyra, Aquarids from Aquarius, Leonids from the constellation Leo, etc.

The Perseids (yes, streaming in from the constellation Perseus), the most famous, spectacular, and eagerly awaited meteor showers of the year, appear from mid-July to mid-August but are occasionally washed out if there is too much moonlight or other background glare. The meteoroids enter the atmosphere at approximately 133,200 mph (60 kilometers per second) relative to the planet. Compare this with the speed of the space shuttle, which orbits at a mere molasses-paced 8 kilometers a second.

The Perseids are also called the Tears of St. Lawrence, after a martyred Christian deacon burned to death by the Romans on an outdoor iron stove. Before dying, he was said

to cry out, "I am already roasted in one side. If thou wouldst have me well cooked, it is time to turn me on the other."

11. HOW ABOUT A WEB CAM? Most telescopes—at universities or specially funded projects—are locked on to highly specific, skinny slices of sky, snooping for black holes, quasars, and other phenomena that add to our understanding of the universe. Very few telescopes are designed for short-range searches. Only the military (since the Star Wars defense initiative of the 1980s) are surveilling local skies—although not for rocks.

Most high-risk near misses come from our own neighborhood. The two most likely sources of impact meteorites in the solar system are the asteroid belt, which is affected by Jupiter's gravity, which can hurl rocks toward Earth, and traveling bodies presumably originating in the Oort Cloud, an unproven but quite possible cluster of distant comets of extremely lengthy periodicity.

If we continue at our present rate, it will take us another five or six hundred years before we discover 99% of them. However, the total number of astronomers involved in looking for earth-threatening asteroids is, in fact, less than the staff of something like a High Street McDonald's restaurant, OK? That is the number of people, worldwide, that we're talking about looking for asteroids.—Duncan Steel (NOVA broadcast, PBS, April 29, 1997)

We can track only a tiny fraction of Near Earth Objects and have calculated some possible collisions over the next century. The risk isn't from NEOs we know about, but the unknown 90% or so that could sucker-punch the Earth at any time.

12. IS THE TAX INCLUDED? Of more than 24,000 meteorites known to have landed on Earth, only 34 are thought to have originated on Mars. (Don't even ask how they got here.) Most of them have been found in Antarctica and North Africa because they are easy to spot on sand dunes and ice. Martian meteorites can sell for $500 a gram. Normal non-Martian space rocks go for a mere $2 a gram. To buy one, try eBay, which often lists more than 1,000 meteorites for auction. Or call Steven Spielberg, one of the most avid collectors (along with Sheik Saud bin Mohammed al-Thani of Qatar). In 2003, a company called Sell2All Inc. offered a rare 1.3 billion-year-old chunk of Mars on eBay. Estimated value: $2 million. But the largest known Martian specimen on the market is the 188-gram Zagami, privately owned. With bids opening at $450,000, this could be the most expensive rock ever sold on eBay.

13. DANCING WITH THE STARS. Slamming through the atmosphere at thousands of miles an hour, meteoroids smash into air molecules, which strip electrons from the meteor. The friction of stripping and recapturing of electrons produces intense heat and bright light. The color and brightness of a meteor trail depends on the temperature and composition of the material colliding with the atmosphere. On almost any night, several meteors an hour can be seen almost anywhere on earth. However, periodically there are meteor showers, with hundreds of meteors emanating from the same spot in the sky. These showers typically last from a few hours to several days.

14. SOUP'S UP. Geologists theorize that meteors may have contributed to the emergence of biological life on Earth. Re-

search suggests that the most intense bombardment of the planetary surface happened about 3.8 billion years ago—which coincides with the time most scientists believe life as we know it originated. Clusters of meteorites over 20 million years ago are theorized to have made an impact on the surface in a way that created underground hydrothermal springs reaching boiling temperatures around 250 degrees Celsius. After tens of thousands of years of cooling, this became a good "soup" environment in which microbes could thrive and develop.

15. APOCALYPSE HOW? One morning in 1908, nearly 1,000 square miles of Siberian forest was seared flat by an asteroid. The explosion was hundreds of times greater than the Hiroshima blast. Its shock waves registered as far away as London. A rock even 5 or 6 miles in diameter—by no means the largest stuff flying around out there—would create an impact equal to the energy of all the nuclear weapons in the world. This would cause unimaginable apocalyptic devastation and ruin everybody's day.

16. ALL TOGETHER NOW. Comets, asteroids, and meteorites have chemistries similar to that of the sun. Some have even been found to carry microbes, a tantalizing hint of life elsewhere in space. (See the chapter on Aliens). One theory of how planets were formed is the "clumping" concept: little chunks of matter bumped into other little chunks and snowballed into larger and larger bodies. Much of this space gack didn't get pulled into the sun, and became planets. The icy, rocky leftovers became comets and asteroids.

17. SAVE THE DATE. The International Meteor Organization (IMO), founded in 1988, has hundreds of members dedicated to fostering international cooperation in the observation, collection, cataloging, and study of meteorites. There is also an American Meteor Organization . . . and a great many other groups, academic and amateur, dedicated to the science.

For example: Arizona State University's Center for Meteorite Studies houses the world's largest academic meteorite collection. Each month the center's museum features a different meteorite of the month.

18. IF LIFE GIVES YOU METEORITES, MAKE . . . JEWELRY. If you stumble across a meteorite, the Nomenclature Committee of the Meteoritical Society requires that you donate 20% or 20 grams (whichever is smaller) to a laboratory for research. You can do what you like with the rest—sell it, make a bracelet, send it back into space.

The Meteoritical Society is a "non-profit scholarly organization founded in 1933 to promote the study of extraterrestrial materials, including meteorites and space mission returned samples, and their history. The membership of the society boasts 950 scientists and amateur enthusiasts from over 33 countries who are interested in a wide range of planetary science. Members' interests include meteorites, cosmic dust, asteroids and comets, natural satellites, planets, impacts, and the origins of the solar system."

19. MISS LILY, CALL THE SHERIFF. If you find your meteorite in South Africa, you must turn it over to the authorities. Meteorites that fall on South Africa are protected under the National Heritage Law, just as antiquities are often the cultural property of their country of origin.

According to the same law, which claims for the state "any naturally occurring object of extraterrestrial origin," little green men landing in South Africa automatically become the property of the state, presumably getting little green cards. But if they wished to leave, they would face strict export permit requirements from the South African Heritage Resources Agency.

220,000 years ago, a meteorite struck South Africa, forming the Tswaing Crater northwest of Pretoria. This is one of the most accessible and best-preserved meteorite impact craters in the world.

20. HEAVENLY HASH. Some literary experts believe that Samuel Taylor Coleridge's lines from "The Rime of the Ancient Mariner" may have been inspired by the Leonid meteor showers of 1797.

The upper air burst into life!
And a hundred fire-flags sheen,
To and fro they hurried about!
And to and fro, and in and out,
The wan stars danced between.

On the other hand, Coleridge was known to use opiates.

* * *

SORRY, TATTOO, BUT THAT IS NOT A PLANE FLAMING TOWARD EARTH

Speaking of things flaming in from outer space, planetary scientists keep unearthing evidence of more and bigger meteor impacts. The best-known whopper crashed off Yucutan 65 million years ago, leading to the demise of about 70% of Earth's species, including the dinosaurs. Its crater—bearing the catchy name Chicxulub—is about 112 miles across and 3,000 feet deep.

Recently scientists revealed a monster 300-mile-wide crater buried a mile underneath East Antarctica's ice. Hitting about 250 million years ago, it triggered a mass wipe-out—some 90% of all living things—and possibly caused the breakup of Earth's single supercontinent into its present descendants. Other geologists postulate an even older impact crater off the northwest coast of Australia. Also enormous, it was previously believed to be of volcanic origin.

Searches, findings, disputes, theories, counter-theories. And lurking behind it all is the growing public awareness that at any time a meteor could sucker-punch our planet, causing another worldwide catastrophe. Could the Mayans be right that the world ends for good on December 21, 2012? Stand by for specifics as to the hour.

20 THINGS YOU DIDN'T KNOW ABOUT MILK

Milk without fat is like nonalcoholic Scotch.

—ANDY ROONEY,
U.S. journalist

Never mind Scotch; they say that brandy is the milk of old age. There are many folkloric references to milk, everybody's first—and presumably best-loved—beverage. The milk of human kindness. Mother's milk. Land of milk and honey. What could be sweeter, more comforting than milk?

Moms all over the Western—although not Eastern or Southern—world urge kiddies to drink their milk to build healthy bodies. A quart of milk a day. "You never outgrow your need for milk." Milk on your breakfast cereal. Milk and cookies. Got milk?

Well, there's another view. Maybe you shouldn't get milk any time after infancy. And some say that even during infancy, milk ought to be exclusively human, not bovine, milk. Check it out.

Milk is for babies. When you grow up you have to drink beer.

—ARNOLD SCHWARZENEGGER,
governor of California

* * *

1. ALL MILK IS SPECIES SPECIFIC. Cow milk is designed to feed baby cows. Human milk is for baby humans. Mouse milk is for baby mice. And so forth. Tampering with the milk of any species—adding chemicals to it; sterilizing, heating, and otherwise modifying it—destroys its natural protective and nutritional value for that species.

According to Stephanie Clark, Ph.D., of the Department of Food Science and Human Nutrition at Washington State University, infants under a year old "should not be fed cow milk, goat milk, or soy beverage." Reason: they are all low in iron, and they differ in protein composition from mother's milk.

Drinking them may contribute to iron deficiency. Breast-feeding or nutritious infant formulas are best for the child for the first 6 months. After that, the Academy of Pediatricians recommends supplementing the baby's diet with iron-enriched infant cereals, ideally continuing breast-feeding until age 1.

This discovery was made fairly recently; it was only in the 1950s that it began to dawn on people that milk was not good for everybody. However, the normal situation was originally regarded as the abnormal one.

—*MARVIN HARRIS, U.S. scientist*

2. MAYBE MOM WAS WRONG. Increasing numbers of physicians are becoming concerned about the potential hazards of human consumption of cow milk. The Committee on Nutrition of the American Academy of Pediatrics has published an

eye-opening report entitled "Should Milk Drinking by Children Be Discouraged?"

Opinions about the benefits of milk differ—sometimes violently. Several books and articles insist that processed cow milk is actually unhealthy for humans. They link it to health problems like chronic diarrhea, colic, iron deficiency anemia, allergies, heart disease, cramps, gastrointestinal bleeding, sinusitis, skin rashes, acne, arthritis, diabetes, ear infections, osteoporosis, asthma, autoimmune deficiencies, and possibly even lung cancer, multiple sclerosis, and non-Hodgkins lymphoma.

We know smoking tobacco is not good for kids, but a lot of other things aren't good. Drinking's not good. Some would say milk's not good.

—BOB DOLE, U.S. senator

3. LET'S GO POSITIVE. Dairy products are supposedly good for your teeth. Cheese and milk can reduce oral acidity, stimulate saliva, and decrease plaque.

Milk is also claimed to reduce the risks of colon cancer and type 2 diabetes and to lower blood pressure. A paper published in the *American Journal of Clinical Nutrition* states that non-fat milk products (such as yogurt) could reduce hypertension by 50%.

Get off your horse and drink your milk.

—JOHN WAYNE, U.S. actor

4. BUT IS IT THE MILK OR THE CHOCOLATE? In a study, cyclists who drank chocolate milk after riding until they were

energy depleted were able to ride 50% longer than cyclists who chugged Gatorade or Endurox.

Detroit Tigers pitcher Justin Verlander paid $3,000 for a chocolate milk. A rip-off convenience store? No. In high school he had no money to buy milk, so he made an agreement with his friend that if he lent him the 50 cents for the milk, Justin would give him 0.1% of his signing bonus, which wound up being over $3 million.

5. LET'S HEAR IT FOR THE COWS. The first cows arrived in Jamestown in 1611. Nineteen U.S. states proclaim that milk is their official state beverage: Arkansas, Delaware, Kentucky, Louisiana, Maryland, Minnesota, Mississippi, Nebraska, New York, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Vermont, Virginia, and (no surprise here) Wisconsin.

There's nothing like sitting back and talking to your cows.

—RUSSELL CROWE, Australian actor

Originally, most milk was produced for local use, rarely being distributed beyond county lines. By the 1950s, better roads (including the interstate highway system) made it possible to ship milk more easily to areas where there was little local production. Typically, milk had been collected in small containers from local dairies every 3 days or so. As more local farmers switched to bigger, better

refrigeration and storage capabilities, and more refrigerated bulk tanker trucks came into use, pickup intervals lengthened and distribution widened.

Cows are my passion. What I have ever sighed for has been to retreat to a Swiss farm and live entirely surrounded by cows—and china.

—*CHARLES DICKENS, British novelist*

6. NO STIR-FRY TONIGHT, GUYS. Speaking of China, the first ice cream on record was eaten by King Shang of China in 618 AD. His staff of 94 ice men whipped up the little treat using buffalo milk and flour. What—no sprinkles?

About 9% of all U.S.-produced milk is used for ice cream, arguably everyone's favorite use of the commodity. Americans spend close to $21 billion a year on ice cream. But frozen yogurt, soy "milk" frozen products, and low-fat ice milk are slowly gaining market share.

The first commercial ice cream was made in New York City by a Mr. Hall, who advertised it in news sheets on June 8, 1786. Ice cream itself had been around for much, much longer, of course. Nero had ice imported by relay runners and horsemen "from distant snow-capped mountains." His chefs flavored the ices with honey and fruit juices as a treat for the emperor's dinner guests. Sometimes he killed his guests after dessert.

I doubt whether the world holds for anyone a more soul-stirring surprise than the first adventure with ice cream.

—*HEYWOOD BROUN, U.S. journalist*

The world's largest ice cream sundae weighed in at nearly 55,000 pounds. It was made from 20.27 tons of ice cream, 4.39 tons of syrup, and 537 pounds of topping. Ice cream sundaes were originally "Sundays," but the spelling was changed to avoid offending religious bluenoses. George Washington's expense ledgers note a "cream machine for ice" on May 17, 1784.

Not to like ice cream is to show oneself uninterested in food.

—JOSEPH EPSTEIN, Polish activist

7. UDDERS OVER MISSOURI. The first cow to fly in an airplane—and be milked aloft—was Elm Farm Ollie, during the International Air Exposition of 1930. During the flight she produced 24 quarts of milk, which were sealed into cartons and parachuted—still warm—to spectators on the ground in St. Louis.

You can only milk a cow so long; then you're left holding the pail.

—HANK AARON, Baseball Hall of Famer

We have no idea what he meant by that.

8. GLUG, GULP, SNUFFLE. Though there's no scientific proof to back up this claim, Australians believe that the amount of milk one consumes is correlated to nasal stuffiness. On another front, Aussie dairy farmers are working with biotech companies to develop milk products that will prevent stomach ulcers.

Helicobacter pylori (H. pylori) is a bacterium suspected of

causing most peptic ulcers. It's not job stress or the mother-in-law moving in: it's a germ (See chapter on Germs). *H. pylori* infections affect many people in the U.S., although most of them don't develop ulcers.

Ulcer sufferers often sip milk or cream to ease their discomfort, which is a temporary remedy, like drinking salt water to relieve thirst. In fact, dairy products may release acids and enzymes that contribute to stomach irritation and cause constipation.

9. GUESS WHAT? Lactose intolerance is not an allergy. It's a condition caused by deficiency of the enzyme lactase, which is needed by the digestive system to break down milk sugar lactose.

I have been dairy free for several years, and I started because I felt it was going to reduce my allergies, which it did, and help me lose weight, which it did.

—*FRAN DRESCHER, U.S. actress*

10. IF NOT MILK, WHAT? If you feel that milk just isn't your cup of tea, boost your intake of pure waters, unadulterated natural fruit and vegetable juices, herbal teas, and (assuming you're a moderate adult) good wines and other grownup beverages.

Worried about calcium depletion? Try eating more green leafy vegetables (spinach, kale, collard greens) and even carrots, an excellent source of calcium as well as vitamin A.

If you want to get a sensual thunderbolt, then you have got to be cocked, locked, and ready to rock, doc. I find that whole milk and lots of vitamin D help.

—*TED NUGENT, U.S. musician*

11. MILK TO BURN. The U.S. is the world's No. 1 milk producer—82.3 million tons a year. Average annual production per bossie is more than 8,200 quarts. Yowza! A century ago it was a mere 1,700 quarts—could hormones have anything to do with this? The record production for a single cow in a single year is 55,660 pounds. She's resting.

Elementary school nutritional education (partly funded by the dairy industry) teaches that dairy products are one of the four basic food groups needed for healthy nutrition. Result: the average American consumes 375 pounds of milk-based products a year. One of every seven U.S. grocery dollars is spent on dairy foods.

I don't need rejuvenation. One vitamin E pill, and I'm okay.

—WILLIAM SHATNER, Canadian actor

12. BETTER THAN SCHLEPPING MILK CANS. The Mongolians invented powdered milk as a practical way of carrying dairy products—which they love—on horseback across the boundless grasslands of Central Asia.

Genghis Khan (1162–1277) and his son Kublai (1215–1294) founded the Yuan Dynasty around 1271. During this "Mongol Period" they introduced new foods to the Han Chinese (a different ethnic group). Mongolians ate game, very few vegetables, some grains, and lots of dairy products, which the Chinese found repulsive. (Ever wonder why there are no Chinese cheeses?) Mongolians continue to enjoy dairy products; the Chinese continue to consider dairy products proof of Mongolian backwardness. Only fermented milk ever became part of the Chinese diet, and it can be found today in large cities.

13. BUTTERFINGERS. In 1915, after dropping and smashing a glass milk bottle, John Van Wormer, a toy maker in Toledo, Ohio, invented the paper milk carton. He patented it that year, but it took 10 more years to perfect a machine to make them. By 1950, Van Wormer's company was producing nearly 20 million cartons a day.

Milk was hard to keep fresh, either in stores or for delivery. It tended to spoil quickly and easily absorbed odors. The returnable bottles delivered by the milkmen of yesteryear were cumbersome and breakable, and they involved time-consuming sanitizing and refilling. Following Van Wormer's development of the "paper bottle," when the proper milk-proof container sealants were found, the days of the glass bottle diminshed.

Milkmen seem so wholesome, and there's no way anybody can be that wholesome.

—MAX CANNON, U.S. cartoonist

14. WHAT HATH LOBBYING WROUGHT? For generations, the idea of milk as "nature's perfect food" has been hammered into American children. It's worked so well that the dairy industry has a massive ad budget and huge lobbying clout in Congress. Public school students are eligible to receive at least a half pint of milk every day, even if they can't pay for it. Warm-hearted charity? Or cold and calculated sales promotion?

Many schools switched from milk cartons to plastic containers because they're much easier for children to grasp and open. So, more children are drinking more milk. In 2002, 5.3 billion half-pint servings of milk were consumed by U.S. school children.

15. ANOTHER KIWI FIRST. Biotechnologists in New Zealand have discovered cows with a gene that lets them naturally produce skimmed milk. The first "skimmed milk" cow, Marge, was found in 2001, and since then scientists have managed to breed calves that carry the same gene. Low-fat herds could revolutionize the dairy industry.

Milk low in saturated fats would be high in the healthier polyunsaturates and monounsaturated fats. In other words, milk that's better for you, and which could also make more easily spreadable butter. Skim milk is currently made by removing much of the fatty cream from whole fat milk. That step would no longer be necessary.

A mind of the caliber of mine cannot derive its nutriment from cows.

—GEORGE BERNARD SHAW,
Irish dramatist

16. DEAD MILK? The bacteria-killing heat involved in pasteurizing destroys harmful bacteria in milk. But in some methods of pasturization, it can also destroy some of the good proteins in milk. Cooking the milk makes it harder to digest.

Although it seems natural and innocent, sitting there in bottles or cartons, milk is one of the most highly processed foods on the market. Homogenization (after pasteurization) emulsifies all its natural fats at high pressure. Then, it's shot through hundreds of feet of metal, plastic, and glass tubes into a refrigerated truck.

Some natural raw milk advocates claim that commercialized processed milk is a weak imitation of the real milk

that nature provides and (far from being the wholesome, healthy product the dairy lobby spends billions of dollars a year promoting) actually contributes to many common illnesses.

I use no milk of any kind. Anything that comes from a cow I don't eat.

—JACK LA LANNE, U.S. health guru

Pasteurizing milk destroys enzymes and cuts the vitamin content by over half. Raw milk naturally contains health-promoting bacteria like *Lactobacillus acidophilus,* which counteracts putrefactive bacteria. Raw milk eventually curdles and sours if it remains at room temperature. But pasteurized milk, devoid of either beneficial bacteria or enzymes, rots.

17. BONE MASS AND MILK. Both Africans and African-Americans consume less calcium and milk than Caucasians but have greater bone density and fewer instances of osteoporosis. Americans get over 800 milligrams of calcium a day from milk; Ghanians get only 1/100th that amount—8 milligrams. This has made them "neither toothless nor . . . immobilized because of repeated bone fractures," as Dr. Frank A. Oski notes.

Oski, author of *Don't Drink Your Milk*, was physician-in-chief at the John Hopkins Children's Center and Professor and Director of the Department of Pediatrics at the John Hopkins University School of Medicine.

For generations, the advice has been "drink lots of milk for strong teeth and bones." But although the U.S. produces and consumes more dairy products than any other country, we have the world's highest per capita incidence of bone fractures and osteoporosis.

Incidentally, our public has become so accustomed to the idea of milk's role in healthy bone development that we tend to view milk advertising as public service announcements, not as product promotion by an industry. One indication of the influence of the U.S. dairy lobby: **In 1999 the Department of Agriculture donated $200 million to America's dairy farmers, even though the wholesale price for milk had reached the highest level in U.S. history.**

18. THE YUKKY SIDE OF THE STORY. Milk and other dairy products are accused of being acid forming and mucus producing. They are said to provide a culture medium for organisms that cause infections, leading to an increased frequency of colds and flu.

One thing all humans share (other than language, the ability to think ahead, and a fondness for reality TV) is mucus. Our bodies make it whether we like it or not. It's composed of water, body salts, and proteins and is designed to trap germs and dirt particles. Antibacterial enzymes and other antibodies also help fight infection. So the next time your nose runs, thank your nasal, sinus, and lung membranes, because the mucus they produce is killing off something that's probably worse than a runny nose.

Mucus is annoying. It interferes with high notes when we sing. But there is only anecdotal—not scientific—evidence that milk produces mucus. Some people insist that dairy

products make their throat feel coated with thick, annoying mucus. Really? So stop drinking milk, stupid! The reality is that no serious research shows any connection between milk and mucus, other than that they begin with the same letter.

19. THERE'S MILK, AND THEN THERE'S MILK. All mammals, by definition, give milk. Cows have no monopoly when it comes to providing food for humans. Significant numbers of health devotees in the U.S., and many more abroad, praise the benefits of goat, sheep, and even horse milk. Raccoon and squirrel fans are mum on this issue.

Information sources for non–cow milks all mention the nutritional and flavor benefits of their products. Goat milk's "slightly sweet and sometimes salty undertone . . . is the milk of choice in most of the world," claims one Web site. They admit it's not conquering U.S. milk drinkers but is available in health food markets, often for those who can't tolerate cow milk.

Tired of counting sheep—or changing sheets? Enthusiasts claim that a cup of hot sheep milk upon retiring can prevent both insomnia and bed-wetting. Sheep milk fans applaud its "rich, bland, slightly sweet taste" and find it much higher in nutritional solids than either cow or goat milk. It contains up to 200% of the calcium, phosphorus, zinc, and B vitamins that cow milk provides. For those who can't eat regular cheese, there are some tasty sheep milk cheeses in dairy coolers as a substitute.

Horse milk seems to have a following among certain gourmets, who appreciate some subtle equine nuances unavailable from less noble lactations. Some go so far as to

claim that horse milk "is now joining truffles and Beluga caviar as one of the most coveted treats in the world."

Horse milk is high in nutrients and health benefits, especially (it is claimed) for metabolic, gastrointestinal, and liver problems. It also speeds recovery from surgery, stimulates internal cleansing, and boosts the immune system. Horse milk—the miracle drug! What will be next? Appaloosa mint ice cream?

Until recently, horse milk was farmed only in small isolated German dairies. Now there are dozens of large-scale operations producing it in France, Belgium, Holland, Germany, and Austria. Nadine de Brabander, who runs a horse farm with her husband, Frans, near Lier in Belgium, said, "You milk a horse in exactly the same way as you milk a cow—you just have to be a bit more careful about being kicked."

20. IT'S NOT THE MILK; IT'S THE CHEMICALS. In 1993, the FDA approved the use of bovine growth hormone (BGH), a genetically engineered hormone that can increase milk production as much as 25%. Milk from BGH cows contains high levels of one of the most powerful growth factors known. Although it doesn't directly cause cancer, it stimulates its growth. Research shows a 700% increase in the risk of breast cancer in women, and a 400% increase in the risk of prostate cancer in men, with high levels of that growth factor.

I'd rather see you drink a glass of wine than a glass of milk.

—JACK LA LANNE, U.S. health guru

* * *

GOT CHEMICALS?

Like so many things, milk has its devotees and its detractors. It seems unlikely that we will soon see the triumph of consumer interests over big business (in this case, big dairy) interests. As long as government agencies are willing to promote chemicals that are more helpful to shelf life than to human life, we will continue to be plagued by a variety of nutrition-related health problems.

But there's more to the milk issue than either nutrition or health issues. True, there is a groundswell of new non-dairy "milk" products designed for those who are lactose intolerant or seriously allergic to milk. But some people want an alternative for reasons of philosophy (like vegans) or for personal taste—they simply prefer other flavors.

Biologically speaking, only mammals give milk. But some fruits and vegetables produce whitish juices that we call "milk" in a metaphorical sense. These milky fluids can be processed to serve virtually all the same purposes as dairy products. Hence soy milk, rice milk, oat or almond milk, flavored non-dairy creamers and dessert toppings—even alternatives to cheese, butter, and ice cream. Whether you go the mammalian or the vegetal route—or both—we wish you bon appétit.

20 THINGS YOU DIDN'T KNOW ABOUT MOSQUITOES

Nnnnn-EEEEEEE-nnnnn-NNNNNNNNNNNNN-EEEEEEEE . . . WHACK!

Few things this side of daytime TV are as annoying as a mosquito whining in your ear. And few things are as satisfying as swatting the little bastard. It is distressing to see the bloody remains, but that's only because the blood is probably yours.

Mosquitoes may be a necessary menu item for birds and possibly other insects, but they are certainly no friend to humans and other red-blooded creatures. Beyond their high annoyance quotient, they spread disease and death. And our many chemical attempts to control their population can harm the environment.

Although mosquitoes have been among us for millions of years, what do we know about these infuriating pests?

* * *

1. HOW MANY ARE ENOUGH? There are more than 2,500—some entomologists claim 3,000—varieties of mosquitoes whining from the Arctic tundra to the tropical rain forests. Most are active at dawn and at dusk, while others enjoy midday feeding. Protein is where you find it.

2. ANY WAY YOU LOOK AT IT, THEY SUCK. Never mind what you've always heard, mosquitoes do not bite. They suck.

A mosquito's "stinger" is called a proboscis—from the Greek *proboskís*, which originally referred to an elephant's trunk. And a mosquito bite in the night can certainly feel elephantine. An insect's proboscis is its pointed feeding snout. The business end of a female mosquito's proboscis contains two pairs of sharp, flexible blades that surround a pair of slender tubes. One sucks your blood while the other injects a chemical to keep your blood flowing mosquito-ward. It's this miniscule injection that deposits viruses and other organisms that spread disease in humans.

3. SUCKING KILLS. Millions of people alive today will die of a mosquito-transmitted disease. Malaria alone claims some 1,000,000 lives a year in Africa. Other top killers include dengue, yellow fever, and West Nile virus.

Now for the good news. Researchers believe that it may be possible to alter a mosquito's immune system so it can't transmit malaria to humans. Scientists at the European Molecular Biology Laboratory, working with the *Anopheles gambie* (the usual malaria culprit), have identified four proteins produced by the insect's body. Two kill the malaria parasite; two protect it. They postulate that these proteins can be genetically altered to wipe out the parasite so it can't be passed on.

Mosquitoes cannot spread HIV or AIDS. And they don't even die of it. HIV-infected humans have very few virus particles in their bloodstream, so if a mosquito sucks one up, it is quickly killed by the mosquito's digestive system.

4. CHECK THE FOSSIL RECORD. Millions of years ago, mosquitoes were three times as large as they are today, with a proboscis three times smaller. As food sources changed, the proboscis-to-body ratio evolved for quicker feeding with less work. Ain't nature grand?

In the early years of the twentieth century, the American Museum of Natural History in New York City exhibited a gigantic sculpture (75 times normal size) of an *Anopheles* mosquito to dramatize the danger of malaria, which was rampant in 1917 and 1918. The display raised awareness of disease-bearing insects and played an important role in public health education. The wax model had brass wires for hairs and was realistic enough to make its point to the public. Scared a lot of little kids, too.

There are no more giant mosquitoes. But crane flies (non-biting but creepily long-limbed) are often mistaken for them.

Probably the saddest thing you'll ever see is a mosquito sucking on a mummy.

—JACK HANDEY, U.S. humorist

5. EVOLUTION MARCHES ON. In 1998, researchers found a new mosquito species in the London Underground, descended from ancestors flying when the tunnels were dug 100 years earlier. Once bird feeders, they now feast on a menu of rats, mice, and people. For genetic reasons they rarely interbreed with above-ground colleagues. Their DNA varies from subway line to subway line.

Well, they stumbled upon a good thing, as anyone can tell you who has spent the autumn and winter in London.

The climate in the Underground is much nicer than on the surface during chilly, rainy weather. It's an ideal breeding ground for mosquitoes: balmy and warm, with lots of stagnant pools of water in which larvae can blossom into whining adulthood. And Tube passengers—although British—are lots juicier than the birds that were the main staple of earlier generations of mosquitoes who buzzed on the surface.

6. THEY GROW UP SO FAST! Depending on the species and the individual, female mosquitoes can produce 100 to 300 eggs at a time. And they hatch quickly—from about 3 days in the summer to 10 days from egg to adult. A critical fact of mosquito life: they must have stagnant water or wet ground in which the larvae can morph into adults. No standing water, no mosquitoes.

The mosquito's life cycle starts with the mother depositing eggs on wet ground or in stagnant water. That's where they hatch into larvae, which are microscopic but quickly become about 1/4 inch or so in length. They wiggle a lot on the surface, breathing through rudimentary air tubes. Instinctively sensitive to possible predators, they dive at any sudden motion in the water (even a shadow passing overhead!). In the pupa stage, the "mosquitito" may dive and move rapidly about. When it emerges as an adult, it's already primed to reproduce. In summer, this entire cycle can take only 3 days. It often takes longer than that to remember to buy insect repellent.

7. MOSQUITO.NET. Abuja, Nigeria, is home to the world's largest mosquito net, unveiled in 2000 as part of a national

campaign against malaria and other insect-borne diseases. Two hundred school children gathered under the net to dramatize the importance of protection against mosquitoes.

Drought smites mosquito populations—but only for a season. Then, studies show, they return in great force. They are, in fact, unstoppable. Consider that they have 200 offspring at once and that they carry diseases that kill someone every 20 seconds. No wonder Aristotle composed a treatise about them, the Greeks wrote them into funeral songs, and the Egyptians cursed them in hieroglyphics.

—PETRI JAASKELA, professor,
University of Helsinki,
Department of Forest Entomology

8. BIG, BIG BUG. The allegedly largest statue of a mosquito is a roadside attraction in Komarno, Manitoba (population 125)—the mosquito capital of Canada. ("Komarno" is Ukrainian for "mosquito." What's up with that?) Sculpted in 1984, it is made of steel with a wingspan of 15 feet. It's also a weathervane, swiveling in the wind.

Hold on there, pardner! Texans claim that the Komarno mosquito is only the second largest mosquito statue. Apparently the town of Clute, Texas (55 miles southeast of Houston), boasts a 26-foot-high bug named Willie-Man-Chew, complete with cowboy hat and boots. The town hosts an annual three-day Great Texas Mosquito Festival every July, which includes events like the 5,000-meter mosquito chase, a Ms. Quito beauty pageant, and even a mosquito calling contest. Everything really is bigger in Texas!

The misery of Komarno, Manitoba, is compounded by the fact that it is only the world's second largest Komarno, too! The Eastern European republic of Slovakia has a town of 40,000 called Komarno. "Komar" means "mosquito" also in Slovak, Bosnian, and other regional languages, including Russian (and it also refers to a class of missile boats in the Russian Navy).

9. HI, SAILOR. When a mosquito detects the whine of the opposite sex, it begins to synchronize its own pitch to match that of the potential mate. Randy males can "relate" to girl frequencies in a second or two. Females take several times longer to synchronize. This is the same as humans in a bar.

According to a University of Bristol study, male mosquito "ears" contain about as many sensory cells as a human ear. This helps them quickly identify and amplify the sound of passing females, so they can have the pursuit advantage. Both males and females have on-board acoustical systems that oscillate when stimulated by certain pitches.

Female mosquito antennae are tuned to around 230 Hz; the guys are up at 380 Hz (for you music lovers, that's the A-flat above middle C)—the "come on over and see me sometime" frequency of female flight sounds.

Music should strike fire from the heart of man, and bring tears from the eyes of woman.

—*LUDWIG VAN BEETHOVEN,*
German composer

Note that he says nothing about what music should do to flying insects.

10. BUG-EYED, YOU SAY? Eyes occupy most of the surface of a mosquito's head. Not eyes into which one may wish to peer lovingly, these compound-lensed organs deliver infrared images not of the potential prey itself but of heat patterns emanating from its body. Like the alien in *Predator*.

As with so many other creatures, vision helps mosquitoes locate resources: food, mates, safe places to lay eggs, etc. Eyesight effectiveness depends on the time of day, cloud conditions, and the amount of available light absorbed by photopigments in their eyes. Images are limited by the various angles of their compound eyes. It's safe to say that mosquito eyesight is vastly different from human eyesight in terms of both resolution and color discrimination. But it's certainly good enough for their purposes. Hungry mosquitoes are great at spotting artificial light sources, at least for purposes of target acquisition.

11. SCRATCH, SCRATCH. Many people with sensitive skin are more than bothered by mosquito bites; they're actually allergic to them. They get swollen, red, itchy bumps—an immunological reaction to digestive enzymes and anti-coagulants that the mosquito injects through her proboscis before sucking blood.

Children and adolescents are more likely to be allergic than adults, who often develop resistance to bug saliva. Those suffering from the allergy should take evasive actions like avoiding the outdoors in the early morning and late afternoon, when mosquitoes go hunting; covering up those appetizing skin surfaces; splashing on repellents; and sleeping under netting. If these strategies don't work—and they probably won't, because mosquitoes are determined little hunters—smear on anti-itch lotions or creams to soothe the

affected areas, apply cold compresses to the lumps, take two aspirins and call us in the morning.

Many workers digging Canada's Rideau Canal (North America's oldest continuously running canal, between Ottawa and Kingston) died of mosquito-borne malaria in August and September 1830. Of 1,316 workers, 787 caught the disease, which killed 27 men, 13 women, and 15 children.

12. EAT YOUR WAY TO IMMUNITY. Some traditions hold that eating garlic, onions, and certain herbs will make the eater an unattractive lunch for mosquitoes. There is no proof of this, since what attracts the mosquito is a combination of many chemical and visual elements. However, eating certain foods may enhance victims' resistance to the effects of the bite.

13. MOSQUITOES THRIVE ON CARBON DIOXIDE. They use your exhaled breath to track you down, especially when you sleep or have been exercising. Fortunately, they clock out at only 1.5 mph—so you can't hide, but you can run, unless you're on a treadmill. Then they'll get you for sure. Hint: An electric fan can disperse the CO_2 in the air near you, making it harder for the little darlings to home in on you.

Male mosquitoes hatch sooner than females, but they also die much sooner. Actuarial statistics vary from species to species, but in general the males live far less time (about a week) than females, whose span is a month or so.

Mosquitoes' lives may be ephemeral, their deaths almost always brutal. But during their transitory span, absolutely nothing will stand in

the way of their two formidable guiding desires: to soak up human lifeblood, and to reproduce.

—*J.R. CHURIN,* A Mosquito's Life, *1929*

14. THE METER-HIGH CLUB? Mosquitoes can mate in mid-air, often in as little as 15 seconds from approach to fare-thee-well. There are no known instances of prior cocktails and dinner.

When it comes to reproduction, mosquitoes are precocious little devils. Perhaps because their lives are so short, they waste no time mating, in some cases even before the male sperm and external genitalia are fully developed. Females are ready to mate almost as soon as they emerge from the pupal stage—and the males know it. Often male mosquitoes lie in wait and pounce on the ladies as they unfold their wings for the first time, those Jezebels.

15. ALL TOGETHER, NOW. It would take 1,200,000 mosquitoes, each sucking once, to completely drain the average human of blood.

In the Arctic, Canadian researchers who bared their arms, legs and torsos reported as many as 9,000 bites per minute from swarming, newly hatched mosquitoes. At that rate, an individual could lose half his blood in 2 hours. What kind of life do you have to have to volunteer for 9,000 mosquito bites?

When a mosquito gets you, just what does she get? Less than 1/1,000,000th of a gallon of blood—on average, four times her total body weight. Now imagine a 125-pound woman weighing 500 pounds on the way home from a ro-

mantic dinner. Like the mosquito, she would probably not eat for another 2 or 3 days.

16. FLYING VEGANS? Male mosquitoes are actually sensitive vegetarians, living on nectar and plant juices. Only females drink blood, for protein to make eggs.

As is the case with certain other species, male mosquitoes are good for only one thing. They are not good providers or protectors. They fly by; they take care of business; they fly on. A female needs to mate only once in her lifetime, since she can stock the elusive male's sperm until she chooses to have a family.

17. ZZZZZ-ZZZZZ. In winter, female mosquitoes hibernate in sheltered places like cellars, sewers, garages, or barns until the warm weather returns. When the temperature gets high enough, she goes back out looking for blood to make eggs.

The belief is growing on me that the disease is communicated by the bite of the mosquito . . . She always injects a small quantity of fluid with her bite—what if the parasites get into the system in this manner?

—RONALD ROSS, Scottish biologist, 1896

18. MISKITO, MOSQUITO—AS LONG AS YOU'RE HAPPY. Central America's so-called Mosquito Coast (a thin strip of land along the Caribbean in Honduras and Nicaragua) is named not for the insect but for a mispronunciation of the name of

the indigenous Miskito Indians. Note: this does not mean there are no mosquitoes there.

The best blood will at some time get into a fool or a mosquito.

—BENITO MUSSOLINI, Italian dictator

19. WHATEVER WILL PETA THINK? A mosquito's brain is the size of the dot over this "i". Its behavior is chemistry driven. When a feeding mosquito's belly is full and hugely distended, a chemical signal shuts down the intake. When that signal is disabled, mosquitoes in lab experiments suck until they explode. Yecchh.

One urban legend states that if you tense or otherwise tighten your skin around the mosquito while she's busy feeding, you can trap her proboscis and she will be unable to stop the inflow of your blood until she bursts. Lab experiments in which entomologists inhibited the natural "appetite cutoff" enzyme during the feeding process have in fact resulted in a number of extremely unappetizing mosquito grenades.

20. CONFUSE THE ENEMY. A successful mosquito repellent, a chemical known by the shorthand DEET, was developed by the U.S. Department of Agriculture. The U.S. Army holds the patent (1946). DEET's effectiveness is based on its ability to discombobulate the mosquito's olfactory sense so she has trouble locating her prey. It's hard to bite something you can't find.

Most repellents on the market simply try to cover up the attractive human smell that invites the mosquito to dine. But another solution is the mosquito trap, a device designed to

lure and then destroy the little pests. These machines mimic the olfactory signatures of humans and some animals. When the mosquitoes follow the counterfeit scent trail, they are vacuumed in and zapped.

But zapping has its drawbacks. Innocent non-biting insects like moths and butterflies also die, and ultraviolet light from the zappers probably attracts far more mosquitoes than it destroys.

Spraying and fogging may do little to discourage mosquitoes and may even increase their presence and resistance to insecticides. (This is not even to mention the adverse effects of spraying and fogging on the environment.) Most sprays are expensive and have limited deterrent time (usually about 4 hours maximum). And they kill not only mosquitoes but "friendlies" as well: butterflies, earthworms, mantis, ladybugs. Even worse, once mosquitoes have been exposed to spray, they develop resistance to it (in just a few quick generations) and come back really buffed up, ready to counterattack, stronger than ever.

* * *

WILL WE EVER BE RID OF THESE ANNOYING CRITTERS?

While some promising advances, based on genetic engineering, are designed to reduce epidemics, it's unlikely that any species that has been around for millions of years, in thousands of varieties, is likely to vanish from the scene any time soon, despite humankind's most earnest wishes and brilliant efforts. The most we

can hope for, it seems to us, is some kind of cautious truce. Wait a second . . . wait a second . . .

Nnnnn-EEEEEE-nnnn-NNNNNNNNNNN-EEEEEEEE . . .

WHACK!

Got another one. There is hope. One at a time. We urge patience.

20 THINGS YOU DIDN'T KNOW ABOUT OBESITY

Oh, I don't want her, you can have her,
She's too fat for me.
She's too fat for me.
She's too fat for me.
I don't want her, you can have her,
Please do that for me.
She's too fat, she's too fat,
She's too fat for me.
—*"Too Fat Polka," words and music*
by Ross MacLean and Arthur Richardson (1947)

The "Too Fat Polka" was a huge hit in 1947, recorded by radio host Arthur Godfrey and also by the Andrews Sisters. That silly little ditty sold about 3½ million copies. But there's no way to calculate how many people's feelings it hurt. In those politically incorrect times, fat people were fair game for cruel jokes. Even today, "fat is funny"—although we try to be more sensitive.

A song becomes a hit because audiences relate to it. Frivolously mean-spirited, the "Too Fat Polka" obviously reflected what many men felt, even if they'd never openly admit it.

It is ironic that in a society that worships slender hard-body

idols, most worshippers are wide soft bodies. In recent years, as waistlines have expanded worldwide (mainly in affluent countries), there has been emerging public awareness of the impact obesity has on physical and mental health and the health care system—not to mention the social and legal ramifications.

There is widespread (no pun intended) discrimination against fat people. The sad truth is that most employers, choosing between two applicants, take the thinner (or better-looking) one, even if the heavier person is more qualified. Similarly, overweight people are subject to slower professional advancement or are denied promotions they might have earned if they were thinner.

So to racism, sexism, and ageism, we can now add a new ism—weightism—as a sad and unpleasant fact of twenty-first-century life. What can we do about it? Let's review some key points.

* * *

1. OBESITY IS EVERYWHERE. It is estimated that if the entire morbidly obese U.S. population lived in one state, that state would have the 12th highest population in the country. This number is expected to add another 28 million people by 2013. About 30% of all U.S. adults (some 60 million people) are technically obese. In the U.K., that number is less: about 20%. There are about 300 million obese people worldwide—more than 60 million in China (and another 200 million overweight). China's obese population has doubled since 1992.

Outside every fat man there was an even fatter man trying to close in.

—*KINGSLEY AMIS, British novelist*

Obesity, simply defined, means too much body fat. Overweight is just weighing too much—which could come from dense bones, thick muscles, or body water content. Clearly, the two conditions overlap, since in both situations the weight is more than the accepted norms for what is healthy for the individual's height.

According to American Sports Data, Inc., in terms of raw body weight:

3.8 million Americans weigh over 300 pounds.

The average adult woman weighs 163 pounds.

400,000 of us (mostly men) are a super-jumbo 400+ pounds!

Obesity develops gradually when you take in more calories than you burn off. It's Nature's unrelenting math. Caloric balance differs for each of us. Factors include eating habits (food choices and intake), genetics, family and cultural environment, and level of physical activity.

Women with 30% body fat and men with 25% body fat are considered obese. Anyone with a body mass index (BMI) of 40% or higher is defined as morbidly obese. About 67% of middle-aged black women are overweight or obese, compared with 45% of middle-aged white women.

According to the *Merck Manual,* "Between 1980 and 1999, the percentage of overweight people increased from 47 to 61%, and the percentage of obese people increased from 15 to 26%."

For the first time ever, overweight people outnumber average people in America. Doesn't that make overweight the average then? Last month you were fat; now you're average—hey, let's get a pizza!

—JAY LENO, U.S. comedian

2. SKIP THAT SECOND HELPING. Obesity increases the risk of heart disease, diabetes, stroke, arthritis, and some cancers. Losing even 5% to 10% of weight can delay, or help, an obese person avoid some of these diseases.

It's so logical and so simple. Fat is the backup fuel system. The role it plays in the body is that when there's no carbohydrate around, fat will become the primary energy fuel.

—ROBERT ATKINS, U.S. diet doctor

Obesity ranks second among preventable fatal diseases. Obese people are at risk for type 2 diabetes, high blood pressure, heart attack, stroke, and some cancers (colon, rectum, prostate, uterus, cervix, ovaries), gallbladder diseases, gastric reflux disease, gout, and reproductive problems. Is it worth it just to collect the full set of toys in a Happy Meal?

Recent studies also link obesity to sleep disorders. Conversely, people who have trouble sleeping are more likely to have weight control problems. It's a vicious circle.

3. FAT KIDS. Obesity is the No. 1 health issue among American children and adolescents. A recent study showed that over 280,000 kids aged 1 to 6 are too fat to use child safety seats. Manufacturers have started making bigger models.

Over the past 30 years, weight problems in children have doubled. Now one of every five U.S. kids is obese. This is a growing problem even among preschoolers. Kids weigh 9 pounds more today than in the early 1960s. Teens' weight has ballooned 12 to 16 pounds in 40 years.

Childhood obesity inclines young people to hypertension,

liver and kidney disease, insulin resistance, type 2 diabetes, hyperlipidemia, and reproductive dysfunction. It also magnifies the risk of adult obesity and consequent cardiovascular disease—even some forms of cancer.

A 2003 study reported that 21% of all elementary students in New York City, from all incomes, are obese.

Who ever hears of fat men heading a riot, or herding together in turbulent mobs?

—WASHINGTON IRVING, U.S. writer

4. OVERABUNDANCE? According to Dr. Marion Nestle, Professor and Chair of the Department of Nutrition and Food Studies at New York University, the U.S. agriculture business now produces about 3,900 calories of food per day per inhabitant. This is 500 more calories than 30 years ago—at a lower per-calorie cost.

Fast-food restaurants now exist—and are multiplying—in every zip code in the U.S. Meanwhile, the food lobby and Big Agribiz, backed by huge ad budgets, are pushing highly caloric fat-filled meals—with ever-growing portions—on an already overstuffed population.

Two years ago, fast-food chain Hardee's introduced the "Monster Thickburger"—two 1/3-pound slabs of beef, four strips of bacon, three slices of cheese, and mayonnaise on a buttered sesame seed bun. It delivers a heftsy 1,420 calories, with 107 grams of fat. Individual caloric requirements, based on body type, activity level, and age vary. But a daily intake of about 1,950 calories a day for women and 2,550 calories for men seems reasonable. How much of that do you want from one burger?

5. NYAH NYAH. According to the *American Journal of Epidemiology*, people who are morbidly obese are five times more likely to be depressed. Overweight or obese children are often stigmatized, suffering from the consequences of anti-fat prejudice. Bad attitudes toward obese youth start as young as age 3. Kids assign negative characteristics to their chubby buddies—being ugly, stupid, and lazy and not having friends. Fat-related teasing and name-calling happens at school.

Children who suffer from this teasing can internalize those negative attitudes, blaming themselves for the unpleasant experiences. Adolescents subjected to teasing about their weight often develop low self-esteem, depression, and a sense of social isolation. Other behavior may include unhealthy dieting, skipping meals, and extra TV time.

6. SPONGEBOB LARGEPANTS. The Center for Science in the Public Interest and the Massachusetts-based Campaign for a Commercial-Free Childhood recently sued Viacom and Kellogg for marketing snack foods to kids. According to the CDC, the rates of obesity have doubled in the last 25 years among adults and children and have tripled among teenagers.

One of the leading causes of overweight in childhood is poor food choices—diets high in calories from fats and sugars, low in fruits and vegetables. This situation is exacerbated by the marketers of fast food, junk food, and sugary beverages, who spend billions of dollars a year to promote "instant gratification" yummies.

Aggravating the problem is the increasing tendency for

today's kids to lead a sedentary lifestyle. Fewer calories get burned off. They don't run around like previous generations. They watch TV, play video games, spend time in front of a computer.

Furthermore, increasing numbers of obese parents are serving as role models, making it even harder for youngsters to avoid becoming overweight themselves. Genetics plays a part, with certain single-gene mutations capable of triggering major childhood obesity, though they are not common.

I don't mind that I'm fat. You still get the same money.

—*MARLON BRANDO, U.S. actor*

7. FAT CHANCE. Physicians in Scotland want fat women turned away from in vitro fertilization (IVF) clinics until they lose weight, since their chances of conception are so, well, slim. The Scottish Committee of the Royal College of Obstetricians and Gynecologists recommends that women with a BMI higher than 30 be placed on a waiting list until they reduce to an acceptable weight, since less obese women are more likely to conceive.

Americans like fat books and thin women.

—*RUSSELL BAKER, U.S. journalist*

"The National Institutes of Health cites overweight as a major reason why the fastest-growing group of women experiencing infertility is those under the age of 25," says Beth Heller, director of Pulling Down the Moon, a Chicago fertility treatment center.

This highlights the need for fertility-oriented weight loss programs that also help women make food choices that increase chances of conception.

It's okay to be fat. So you're fat. Just be fat and shut up about it.

—*ROSEANNE BARR, U.S. actress*

8. THE DISAPPEARING AMERICAN DINNER TABLE. People who treat themselves to breakfast or dinner in restaurants double their risk of becoming obese.

A major factor in eating patterns over the past two generations is the increase in working mothers, divorced parents, and an overall hurry-hurry society. Result: more fast food, more pizza deliveries, and more quick snacks instead of balanced dinners at home. About half of all U.S. food dollars are spent outside the home, with implications for obesity and general health.

You cannot achieve environmental security and human development without addressing the basic issues of health and nutrition.

—*GRO HARLEM BRUNDTLAND, World Health Organization*

9. EVEN PROFESSIONALS CAN BE BIASED. Social scientists have documented cases of anti-obesity bias among doctors, nurses, psychologists, medical students, and dieticians. Apparently, even health care professionals often perceive obese patients as unappealing, weak-willed, lazy, or unintelligent.

Sadly, awareness of this attitude by those who are theoretically helping them can discourage obese people from

seeking or continuing treatment. This is particularly true for obese women.

I found there was only one way to look thin: hang out with fat people.

—*RODNEY DANGERFIELD,*
U.S. comedian

10. CHOICES, CHOICES. According to a study by the Rudd Center for Food Policy and Obesity at Yale University, nearly half of the 4,000 people responding to an online survey about obesity said they would give up a year of their life rather than be fat.

Yet, in another 2002 survey, only one out of five women said losing weight was a top priority.

Between 15% and 30% of the Rudd respondents said they would walk away from their marriage, give up having children, be depressed, or become alcoholic rather than be obese! Furthermore, 5% and 4% said they would rather lose a limb or be blind than be overweight.

11. IT REALLY IS GLANDULAR. Boston scientists recently found that 1 in 10 people carries a common genetic variation that may make it extremely tough to control weight. Other scientists believe about half of obesity is genetically determined.

Thin people are beautiful, but fat people are adorable.

—*JACKIE GLEASON, U.S. actor*

12. MAYBE SLIM IS SEXY. Duke University Medical Center found that women and men who lose just 10% of their total body weight reported significant improvement in their sex lives.

They apparently managed to reverse the six negative aspects of sexual quality of life: feeling sexually unattractive, lack of desire, reluctance to be seen undressed, difficulty with sexual performance, avoidance of sexual encounters, and lack of enjoyment of sex.

13. PADDING THE STATISTICS? Eric Oliver, a professor at the University of Chicago, blamed the "obesity mafia" for false health standards about weight gain. The "obesity mafia," in his view, consists of agencies such as the National Institutes of Health, the Centers for Disease Control, and the Food and Drug Administration.

The CDC reports that 320,000 deaths are related to obesity, but another government study found that obesity actually causes some 112,000 deaths each year.

14. THE HIGH COST OF HIGH WEIGHT. Some observers think that obesity could play a major role in bankrupting our healthcare system. About $100 billion a year is spent on obesity-related treatment.

Some fast facts: Nearly $50 billion is annually spent on diet programs. In 2003, two kids sued McDonald's, blaming them for their obesity and diabetes from eating Big Macs and chicken nuggets. A 9-week course at Camp Shane, an upstate New York "fat camp," costs $7,150. The high-end

mattress maker Select Comfort sells a grand king-size bed, 30% larger than the traditional.

15. BURN FAT OR BURN FUEL. The average weight of Americans increased by 8.5 pounds from 1991 to 2000. Airlines spent $275 million on 350 million additional gallons of fuel in 2000 to compensate for that additional passenger load. That extra fuel translates to 3.8 million tons of CO_2 emissions blasted into the upper atmosphere.

From 1938 to 2003, the FAA assumed that the average male passenger weighed 170 pounds. In 2004, the estimate was 184 pounds. Domestic air carriers burned 14.8 billion gallons of jet fuel in 2000.

Southwest Airlines now charges larger passengers for two seats.

16. CHECK THAT BAG? In 2002, Virgin Atlantic airlines paid Barbara Hewson of Wales £13,000 compensation after an obese person sitting next to her on a transatlantic flight crushed her. Barbara suffered a blood clot in her chest, torn leg muscles, and acute sciatica. She was bedridden for a month. Virgin reportedly offered Barbara a gift basket worth £15 as compensation. She held out.

If anyone wonders why the airlines are not doing well it is because flying has been made such an unpleasant and degrading experience.

—KEITH HENSON, U.S. scientist

17. HI, BIG GUY. Manuel Uribe, a 42-year-old man weighing 1,200 pounds—the equivalent of 5 newborn elephants—has

been bedridden for the past 5 years. At 22 years old, Manuel weighed 290 pounds. In August 2006, he tipped the scales at 400 pounds lighter after being on the Zone diet.

Stand by your man . . . for a while. Over a decade ago, Manuel's wife was frightened by his increasing size. So she did what every loving wife would do—she abandoned him!

The world's heaviest man was Jon Brower Minnoch. He died in Seattle in 1983, tipping the scales at 1,400 pounds. The world's lightest man was Claude Ambroise Seurat. The French "living skeleton" (1798–1840) weighed only 43 pounds!

I guess I don't so much mind being old as I mind being fat and old.

—*BENJAMIN FRANKLIN,*
American statesman

Steve Vaught, a 40-year-old from San Diego, developed an eating disorder, became depressed, and gained 150 pounds after accidentally killing two elderly pedestrians. To lose it, he walked across the country from Oceanside, California, to New York City, losing over 100 of his 410 pounds. En route he wore out 15 pairs of shoes, 12 pairs of pants, three shirts, and 30 pairs of socks.

After losing 100 pounds, 58-year old former Marine and Vietnam vet Abdul Baseer-El started MOVE, a 10-week program to help other veterans lose weight. About 11,000 veterans are registered with MOVE. Nearly two out of 10 men and four out of 10 women of military recruiting age weigh too much to be eligible. According to

the Department of Veteran Affairs, of 7.5 million veterans that receive health benefits, more than 70% are overweight. In 2002, more than 50% of U.S. soldiers were overweight.

18. EATING DISORDERLY. "Competitive eating is not a gluttonous act," said champion eater Jason "Crazy Legs" Conti. "These are highly trained pro athletes at the top of their game."

Sonya Thomas (105 pounds) is ranked one of the top five competitive eaters in the world and holds records in over a dozen different food categories, including 46 dozen oysters in 10 minutes, 11 pounds of cheesecake in 9 minutes, and 167 chicken wings in 32 minutes. Where does it all go?

Eric "Badlands" Booker, the 420-pound competitive eater and a New York City subway conductor, released his first record, "Hungry and Focused."

Bayer, the German drug company that makes Alka-Seltzer, recently severed ties as a sponsor of events with the International Federation of Competitive Eating. A spokesperson for the Coalition Against Bayer Dangers said, "It is obvious to all that excessive eating is a danger to health. Paradoxically, Bayer offers remedies to cure the diabetes that is often caused by the very events they are sponsoring."

19. DON'T FORGET THE SIDES. Mississippi, home of the mud pie, Cajun fried pecans, sweet potato crunch, fried shrimp, and catfish, is also—coincidence?—the fattest state per capita in the U.S.

According to a 2005 survey, Mississippi is the only state in the union with more than two-thirds of its people either overweight or obese. Yet, Mississippi husbands resist their wives entering weight loss programs. They say, honey, stay just the way you are—or get out.

West Virginia, Louisiana, and South Carolina follow close behind Mississippi. The most obese states are concentrated in the South (excluding Florida, a Southern state only geographically). The leanest states are in the non-coastal West and New England. Colorado remains the slimmest in the union.

20. WHEN IS HAPPY HOUR? U.S. health club membership now hovers around 40 million. At the turn of the present century, 5.4 million Americans were paying for a personal trainer—up 30% from 1999. As a nation we are very fitness conscious, but we have to fight constantly to overcome our lack of discipline. American fitness behavior always seems to lag behind our intentions.

The commercial health and fitness industry is full of all types of quick-fix schemes, making it frustrating to know what to believe in or trust.

—LEE HANEY, U.S. athlete

* * *

THE SLIMMING OF AMERICA

Assuming we agree that thinner is healthier (we stop short of anorexia), what are we doing about it? Depending on whose statistics you follow, an average of about 70% of all American adults in recent years intended to either (a) lose 5 pounds or more or (b) maintain their present weight. Of those, only 7% went on a

controlled diet. Another 49% claimed they were "watching what they ate." Many reported good short-term results, but only about 30% managed to keep off the extra ballast.

The fitness craze peaked in the 1990s and has not been a major factor in American health since then. But there are faint glimmers of a new dawn just below the horizon. High-protein low-carbohydrate diets, awareness, and regular exercise programs seem to be regaining vitality.

Although only about 20% of the population exercises regularly, there is fairly unanimous agreement on its health benefits. Pitted against our national determination to slim down are two powerful opponents: our overflowing national food supply and the calorie mega-marketers with their mega-budgets. It will be quite a contest.

Our growing softness, our increasing lack of physical fitness, is a menace to our security.

—JOHN F. KENNEDY, U.S. president

20 THINGS YOU DIDN'T KNOW ABOUT RATS

The trouble with the rat race is that even if you win, you're still a rat.

—LILY TOMLIN, U.S. actress

Almost nobody likes rats. All right, let's be candid. Almost everybody hates rats. They are considered disgusting, creepy, disease-bearing, destructive, vicious, and generally bad company. So why an entire chapter about these loathsome rodents?

Because they have another side that makes them fascinating. They are intelligent, easy to train, and helpful for research in labs both on Earth and in space. They are even being groomed for crucial, selfless humanitarian services (more on that below). Finally—are you ready?—there are growing numbers of enthusiasts who consider rats to be adorable, cuddly pets.

* * *

1. THEY ARE EVERYWHERE. The brown rat *(Rattus norvegicus)*, also called the Norway rat, and its more acrobatic Asian cousin, the black rat *(Rattus rattus)*, enjoy a nearly worldwide distribution, thanks to their skill at stowing away.

The rat family we know best is believed to have originated in the grasslands of China, making its way via Europe

to the New World just before the American Revolution. Bafflingly, *R. norvegicus* has no proveable link to Norway.

In college I castrated 21 rats, and I got pretty good at it.

—LISA KUDROW, U.S. actress

A rat is not just a mouse on steroids. Besides size and lifestyle, the body types are different. Mice: smooth tail, pointy nose, dainty little feet, floppy ears, large eyes. Rats: rough scaly tail, blunt nose, big paws, stingy little ears, beady eyes. Mice like to nest in walls, under debris, or outdoors. Rats prefer to burrow down along house foundations. They also like basement living. While mice tend to squeeze through cracks or holes in walls, rats will boldly come up through drains or toilet pipes.

Mice are mainly vegetarian, seeking grains, seeds, or dry pet food. But if hungry enough, they'll eat paper, soap, cloth, or whatever. Rats prefer protein—meat and fish. But, like mice, they will eat virtually anything in a pinch.

Mice are mousey, skittering away from danger. Rats are somewhat more aggressive and will attack if cornered. They climb, dig, and swim well. Mice rarely venture farther than 10 to 30 feet from home. Agoraphobes, they hate open spaces. Rats often roam hundreds of feet from their nest for food or water.

The house mouse has a tiny skinny body, only 1/2 ounce to 1 ounce fully grown. His tail is semi-naked, as long as head and body together. The Norway rat's body is solid, 12 to 16 ounces as an adult. His ears don't reach the eyes when pulled down, and the tail is shorter than head and body combined.

2. NOT ALL RATS LIVE NEAR HUMANS. Of the 56 known species, many live in remote habitats like marshlands and rain forests, and some are endangered. How sad!

3. PIED PIPERS. In the mid-nineteenth century, Jack Black, official rat catcher for Queen Victoria, found several color variations of the brown rat and domesticated several. Eager owners of his pet rats included the queen herself, and it's rumored—disturbingly—animal lover and kiddie book writer Beatrix Potter (1866–1943).

Domesticated rats make good pets, like ferrets or guinea pigs. Not all rats are filthy sewer-dwellers who spread disease and feast on unguarded newborn babies. Most tame rats, descendants of the (brown) Norway rat, live a life free of serious diseases and are friendly to their handlers.

People for the Ethical Treatment of Animals (PETA) believes in compassion for all animals, and protested an episode of the TV show *Survivor* that showed "castaways" gleefully killing rats. Among PETA's souvenir coffee mugs is one with the motto "Rats Have Rights."

4. CHOMP. Rats' front teeth grow up to 5½ inches a year. They wear them down by continuously gnawing on anything around them—cement, brick, wood, lead pipes, small animals. Since their teeth have no nerves, grinding does not hurt them.

The word "rodent" comes from the Latin *rodere*, "to gnaw."

Unlike humans, rats get only one set of teeth, which they maintain through grinding. Trim your pet rat's teeth with the same tools you use for dog or cat claws—or your own toenail

clippers. But it will probably be a two-person job. Rats wiggle a lot.

5. THAT HUSSY. A female rat can mate as many as 500 times with various males during a 6-hour period of receptivity—a state she experiences about 15 times per year. Thus, a pair of brown rats can produce as many as 2,000 descendants a year if left to breed unchecked. (Rats mature sexually *very* early.) An average rat's life span is 2 to 3 years.

The Norway rat prefers to breed in spring and fall. A short gestation period (about 3 weeks) usually produces a litter of 8 to 12 pups. The rat comes into heat every 4 or 5 days, starting as early as age 8 weeks. Unfettered by incest taboos, she mates even with close relatives, and bears four to seven litters a year. We will not run short of rats any time soon.

During the mating dance, the female skitters back and forth, then spins around and plants her legs. When she raises her head and tail and wiggles her ears, that's a go for the male. Yes means yes! The male approaches to sniff and lick the female before mounting her. Like a lion, he will grasp her neck scruff in his teeth. Often the early mounting is foreplay, although—as with humans—it is possible for insemination to occur very quickly during a single mounting.

All nature's creatures join to express nature's purpose. Somewhere in their mounting and mating, rutting and butting is the very secret of nature itself.

—GRAHAM SWIFT, British author

That does bear some serious pondering.

6. HARDY ANIMALS. A rat can tread water for three days, survive being flushed down a toilet, and return to the building via the same route.

These are tough, flexible little guys. Adult rats can squirm through holes 1/2 inch in diameter. They can chew through almost anything, with astonishing jaw power over 20,000 pounds per square inch—roughly 10 times the estimated biting power of a pit bull! (Some squirrels and gophers are similarly talented. But you're far more likely to be bitten by a human than by a rat.)

Adult rats can leap 3 feet straight up and 4 feet outward, and climb almost anything with even a tiny paw-hold. They easily survive falls of 50 feet or more.

The early bird may get the worm, but it's the second mouse that gets the cheese.

—*JEREMY PAXMAN, British journalist*

7. THE DOWNSIDE OF RAT LIFE. Rats are known to transmit several potentially fatal diseases to humans, including viral hemorrhagic fever, plague, Weil's disease, and Q fever. On the bright side, it is extremely rare for a human to get rabies from a rat.

It is uncommon for a rat bite to transmit disease. It is almost always a flea or other parasite living on the rat that is the vector for the illness.

Healthy citizens are the greatest asset any country can have.

—*SIR WINSTON CHURCHILL, British statesman*

8. MISLEADING WORD. The semi-expletive "drat!" has nothing to do with rats. It's a short form of "od rat," a euphemism for "God rot," which was used like "Goddamn."

It is an immense loss to have all robust and sustaining expletives refined away from one! At moments of trial, refinement is a feeble reed to lean upon.

—ALICE JAMES, U.S. writer

9. RAT WORSHIP. A Hindu temple dedicated to the rat goddess Karni Mata in Deshnoke, India, houses more than 20,000 rats. Watch the undulating fur floor! Thousands travel far to pay respect to the rats, who are presumably reincarnations of Karni Mata and her clansmen. Let's hope visitors are vaccinated—just in case.

Hindus believe that gods can appear in any form they choose, not just the ones humans find appealing. Anyone who accidentally kills a rat must make physical restitution to the goddess—a solid gold rat. So be careful when you visit the shrine of Ganesh, the elephant god. You could go broke in India.

Then you must look for a new body. That's what we call reincarnation.

—ALEX CHIU, U.S. businessman

Look no farther than the nearest water pipe or pile of debris.

10. WE HAVE ONLY OURSELVES TO BLAME. At the dawn of the agricultural age, humans learned to grow and store food,

which proved beneficial to both humans and rats. Now neither had to wander far for lunch. Everything was in one convenient sheltered location, where humans and rats alike could also nest. Could domestication be far behind?

Fancy rats of many colors began to be domesticated in the early 1800s. A major step was taken in 1895 by the pioneering British, who founded the National Mouse Club, (NMC) which, like the Royal Kennel Club for dogs, established standards for mouse breeds, sponsoring shows and contests.

In 1901, rats gained respectability when the "Mother of Rat Fancy," Miss Mary Douglas, successfully lobbied for rats' admission to the NMC. By 1912, the club name reflected this acceptance by becoming the National Mouse and Rat Club. This was the golden age of fancy rats in the British Isles. But alas, when Miss Douglas died in 1921, rat appreciation plummeted. By 1929, the club had dropped "rat" from its title, becoming once again the National Mouse Club. The Great Depression had come to Ratville.

British rat enthusiasts licked their wounds, regrouped, and in 1976 established the National Fancy Rat Society, the first known organization (at least, run by humans) for rats only.

As stated on the Web site www.nfrs.org: The NFRS is the best way to find out about the latest in rat care in the UK. Its journal, *Pro-Rat-a,* is published every 2 months and has articles on health care, housing, breeding, showing, and tips and stories from people who keep pet rats. It covers a wider range of topics, and tips and stories from other people who keep pet rats provides more up-to-date information, than any book can offer. . . . When you join the NFRS, you are put into contact with a network of rat experts with the society.

In 1978, the U.S. created the Mouse and Rat Breeders' Association; in 1883, the American Fancy Rat and Mouse Association (AFRMA). On the Internet, those organizations and others can direct you to a mushrooming list of rat resources and support groups. See www.afrma.org/breederlist.htm and www.rathelp.org among others.

No wild enthusiast could rest, till half the world like him was possessed.

—*WILLIAM COWPER, British poet*

11. A VARIED MENU. According to a study by Martin Schein, founder of the Animal Behavior Society, the favorite foods of city-dwelling brown rats include scrambled eggs, macaroni and cheese, and cooked corn. But in a pinch they will cheerfully eat their own feces, purely for the nutritional value. Nourishment is where we find it.

Rats have eaten anything within range of their snouts—including human food—for thousands of years. They like fruits, vegetables, and protein. Modern lab rats and pets have dietary products especially formulated for them. Yes, there is Purina Rat Chow, and other popular feeds like Harlan Teklad and Constant Nutrition™ Laboratory Rodent Diet.

I think nutrition is very important. If you eat bad, you feel bad. If you feel bad, you do bad things.

—*DON VAN VLIET, U.S.artist*

Like chew through plasterboard walls.

12. RAT MYTHS EXPLODED, PART ONE. It is said that well-fed city rats can grow as big as small dogs or cats. Reality: Not unless they have a glandular condition. Typical urban rats (especially in the U.S.) rarely weigh more than about ½ pound. The record granddaddy rat was only 1⅓ pounds.

More misinformation: "For each rat you see, there are dozens more in the nest; and rats outnumber humans two to one in your city." While there are probably more rats around than most people would like, there is no documentation of that ratio. Most rat species live in the wild, and indications are that in big cities humans outnumber rats by a significant margin.

Another myth is that rats live down deep beneath the earth, becoming aggressive when on the surface. Of course, rats that live in sewers are, in fact, deep beneath the earth. But most live in burrows only a foot or two deep. And, for all their intelligence, there is no evidence that their personalities change when they surface.

13. SURE, YOU LIKE ANIMALS, BUT . . . In June 2006, animal rescue workers in Petaluma, California, found Roger Dier in his one-bedroom home overrun with more than 1,000 brown rats. The brood began after the obsessed collector took pity on a baby rat he had planned to feed to his pet python.

From Johannesburg, South Africa, come disturbing reports of a sudden infestation of black and brown rats—and a mysterious black-and-white hybrid never seen before. The rodents are swarming throughout slums and affluent suburbs. One pest control expert has not seen such an influx in more than 30 years on the job. Although health control authorities know which diseases black and brown rats often carry, the

potential health risks of the new black-and-white variety remain a question mark.

I could do without the bubonic plague.

—JERI RYAN, U.S. actress

14. GRRRR! EEEEP! Rat baiting, a popular sport in nineteenth-century London, pitted a man or a dog against hundreds of rats. Jacko, a 13-pound bull terrier, set the record in 1862 when he killed 100 rats in 5 minutes, 28 seconds.

One aspect of the dark side of human nature is our fondness for blood sports—fox hunts, cockfights, obliterating unsuspecting deer from miles away with telescopic rifles to "thin out the herd," the stock market, and worse. We have little affection for rats, but it is unprovoked cruelty to massacre them just for recreation.

Despite the Cruelty to Animals Act of 1835, English "sporting clubs" continued for decades (with law enforcement looking the other way) to provide "entertainments" where gentlemen could bet on the outcome of various acts of cruelty to animals—including rats.

Atrocities, which will go undetailed here, continued until the early twentieth century, when they were gradually replaced by dog shows instead of kill-fests.

The clever cat eats cheese and breathes down rat holes with baited breath.

—W. C. FIELDS, U.S. comedian

15. HUMANITARIAN RODENTS. Rats are being trained to sniff out anti-personnel landmines and unexploded ordinance (UXO) that kill and maim innocent people in dozens of countries worldwide.

Tanzania, along with dozens of other countries, has long suffered from landmine infestation. It is cheap, fast, and easy to sow mines; expensive, dangerous, and time consuming to remove them. Countless tons of explosives remain active for years. Now rats come to the rescue, with their keen sense of smell.

At Sokoine University of Agriculture in Tanzania, rats are being rewarded with banana pellets for detecting traces of explosives used for anti-personnel mines. Rats are faster, lighter, and nimbler than sniffer dogs. They are also easier to transfer to different handlers, since their loyalty is to bananas, not to humans.

Rats learn to sniff out and scratch at the mine location, then wait for their reward. Having located the mine, they move away so a human can remove or destroy it. Because rats are small and light, they scamper right over a minefield without detonating the charges. So far, no rats have been hurt during the program.

The project is run by Belgium-based research organization Apopo, with support from humanitarian de-mining organizations. After training in Tanzania, field trials for the sniffer rats begin in Mozambique, whose recent civil war left some 500,000 unmapped landmines in the ground and thousands of children legless or blind.

As a footballer I can't imagine life without the use of one of my legs . . . Sadly, this is exactly what happens to thousands of children every year when they accidentally step on a landmine.

—*RYAN GIGGS, Welsh soccer star*

Rats are also being trained to locate people trapped in collapsed buildings, mine cave-ins, and landslides.

16. SPACE RATS. In 1957, a Russian dog, named Laika—"barker"—was rocketed into space and was the first living creature to die there, only hours after launch. In 1961, the French sent Hector the rat into the lower atmosphere, thereby establishing the credentials of the species—*Rattus,* not *Homo gallicus*—as bold, if unwitting, experimental subjects.

Rats were the first animals to be anesthetized and undergo surgery in space to learn whether zero gravity affects muscle development. It does.

For generations, rats have been used for laboratory experiments. Occasionally, humane educators substituted diagrams, photos, or computer modeling for invasive techniques. In 1999, the enlightened Dutch created a rubber rat for anatomy study. Correct in all physiological details, it substitutes for the 3,000 or so rats killed each year to teach what students can now learn from rubber models! Unlike real rats, the models can be used over and over, without any creepy squealing and squirming.

A fool is a man who never tried an experiment in his life.

—*ERASMUS DARWIN,*
British scientist

17. ARE YOU A RAT? You are if you were born in 1912, 1924, 1936, 1948, 1960, 1972, 1984, or 1996, according to Chinese astrology. This makes you quick-witted, resourceful, and something of a fashionista. Exactly like a rat, except for the wardrobe.

The Year of the Rat is a time of hard work and prosperity, especially for those born in that year (one in every 12). In the West we go through the entire zodiac in a year, roughly one sign a month. Asians take twelve years for their cycle.

I don't believe in astrology; I'm a Sagittarius, and we're skeptical.

—*ARTHUR C. CLARKE,*
British scientist and author

18. KEEPING COOL. No matter how nervous they get, rats never sweat. They regulate their body temperature by constricting or expanding blood vessels in their tails.

The rat's tail is an extension of its spinal column, with three superimposed layers. Its core is vertebrae, enclosed in a layer of tendons (to allow movement), all neatly wrapped up in rat skin. Blood vessels run along the tail between the tendons.

Rats use their tail for heat dissipation, like a dog's tongue or a human's skin. The tail has no fur, has a large surface-to-volume ratio, and is loaded with blood vessels, especially at the tip and midpoint. Although it takes up only 5% of the rat's body surface, it dissipates 17% of its heat. The warmer the rat, the more blood pumps through the tail to radiate heat out of the body.

They all ran after the farmer's wife.
She cut off their tails with a carving knife.

Did you ever see such a sight in your life
As three blind mice?

—"Three Blind Mice" by Thomas Ravenscroft
(1609)

Rats use their tails for balance, just like squirrels. When they run, they don't drag their tails but hold them slightly off the ground, moving them from side to side like a rudder or stabilizer. (Think of a tightrope walker's pole.) The tail is a counterbalance, maintaining a center of gravity.

Tails are also a handy gripper while rats are climbing branches or pipes. But as strong a muscle as it is, never pick up your pet rat by the tail, because the skin can come loose, and the many blood vessels mentioned above can be injured.

In times of joy, all of us wished we possessed a tail we could wag.

—W.H. AUDEN, British poet

19. RAT MYTHS EXPLODED, PART TWO. Some people think that rat packs roam for miles to escape noisy construction. No. Although rats can roam, they prefer to be homebodies, typically going just far enough to find food and shelter. That said, it is likely that eliminating rodents from proposed construction sites will limit their migration to nearby neighborhoods.

Contrary to the popular wisdom, construction projects do not increase the rodent population. Rats reproduce when and where they choose, construction or not. They are rarely disturbed by routine roadwork, only by major demolition or

excavation. Many cities require a rodent control protocol before demolition permits are issued. Public works contracts involving excavation or underground utility work also make provisions for rodent control.

Another common fear is that if baited traps are set, bloated bodies of rats will stink up streets and parks. Unrealistic. Rat traps are set frequently, but we hardly ever see dead rats because they usually go back to their nests to die.

20. RAT-PPROCHEMENT. In 2006, it was reported that a team of scientists at Tel Aviv University in Israel had created a brain chip out of rat neurons.

One pictures a generation of extremely brilliant *Homo sapiens* capable of skittering gracefully along telephone cables at great speed. We leave the rest to the reader's imagination.

* * *

BE NOT ARROGANT, MR. SAPIENS

This quick glimpse of ratly reality should awaken the reader to interesting possibilities for the future of that species. Does rats' high level of trainability suggest that they may be evolving faster than humans, socially as well as intellectually? They are quick problem solvers. And they are adaptable, durable, and social. Although they will kill to feed themselves, defend their territory, and protect their young, rats do not make wars or—as far as we know—try to impose the cultural quirks of their breed upon rats of other breeds.

Their vision, compared with that of humans, is blurry, short of focus and limited to impressionistic smudges of greens, blues,

and grays. That said, could they perhaps be seeing things that escape the vision of *Homo sapiens?*

Although rats have a longer history on Earth than we have, humans still have the upper hand. But we must not take for granted our position as No. 1 species on the planet. Any year now, *Rattus* may develop an opposable thumb—and then what?

I think there will be radical changes. But I don't actually think that within the next 100 years the natural world will be reduced to rats and cockroaches, nor do I think that the plant world will be reduced to some kind of desert.

—*DAVID ATTENBOROUGH,*
British naturalist

Attenborough is such an optimist.

20 THINGS YOU DIDN'T KNOW ABOUT SEX IN SPACE

Weightlessness will bring new forms of erotica.

—ARTHUR C. CLARKE,
British scientist and author

In all of human history, ever since creatures like us first looked up in bafflement at the cosmos, only a couple hundred of us have ascended into it. Fewer still have spent more than a day or two there. In the new millennium, we have high expectations of establishing a permanent foothold in space. Over 25 nations have participated in humanity's outreach to the stars. Our many diverse cultural backgrounds will continue to color the human aspects of this program. Among those human aspects are sexual interactions.

I'd thought sexuality was instinctive or natural, but it's profoundly linked to inner security and cultural context.

—TAHAR BEN JELLOUN,
Moroccan poet

It is NASA's policy to continue denying that anything sexual—not even petting or masturbation—has ever occurred on their mis-

sions. But few mentally intact people believe these protestations of purity. Given human nature, it seems virtually certain that at some point, some sort of sexual activity must have occurred in space.

But wait. Is sex even possible in weightlessness? Clearly, given the current conservative quasi-religious political climate, we wouldn't expect NASA to admit it even if they were conducting experiments on human sexuality in space. (What? Taxpayer dollars used for . . . naughty purposes?) There is still a strong puritanical strain in the U.S. Sexuality is broadly stigmatized, despite our increasingly sex-obsessed society. A more enlightened future NASA might be more candid about the issue. But don't hold your breath.

Things forbidden have a secret charm.

—*TACITUS, Roman historian*

* * *

1. WHO'DA THUNK? Space was initially the monopoly of the U.S. and the U.S.S.R. But Afghanistan, Austria, Belgium, Bulgaria, Canada, Cuba, Czechoslovakia, France, Germany, Great Britain, Holland, Hungary, India, Israel, Italy, Japan, Mexico, Mongolia, Poland, Romania, Russia, Saudi Arabia, Syria, Ukraine, and Vietnam have also produced astronauts.

Note that some countries in this group have occasionally been enemies but are now part of a broader, more significant human community effort. This gives reason for hope.

2. EVEN ASTRONAUTS ARE PEOPLE. We might assume that NASA is eagerly investigating all human, as well as technological, aspects of space flight—including sexual protocols for long journeys. But there's no evidence that this is the

case. To expect astronauts to deny their human nature forever is naive and unreasonable. Do we want them to be machines or people?

Some insiders believe that sex—beyond masturbation—has already occurred in space. Others think that NASA's program is too regimented, and its participants too disciplined, to allow such close encounters. But sexuality is part of human nature. When we go into space we do not leave human nature behind.

Subdue your appetites, my dears, and you've conquered human nature.

—CHARLES DICKENS, British novelist

Astronauts of both sexes are type A personalities: highly motivated, extremely competitive. This makes it even more probable that someone has tried to be first to "score" in outer space—even if it remains a closely guarded secret for the rest of his life. Given the intelligence, training, and physical prowess of the expanding astronaut population, chances are that some could have found appropriate partners. If the opportunity and urge present themselves, sex can be accomplished quickly, if need be, and satisfactorily. Under such pressed circumstances, dinner, violins, and candlelight can be dispensed with.

3. WRAP IT. While there is no proof of masturbation in space, during a lecture at Maryland College in 2001, Professor David Theison explained that "objects and bodily fluids float around unless fixed to a surface. If you vomit in zero gravity,

it just kind of hangs there." This clearly happens with other liquids, too.

One recent study notes that in the early 1970s, a physician recommended regular masturbation for *Skylab* astronauts to maintain prostate health and avoid urinary tract infections during their 84-day mission. No postflight urological reports have emerged.

Rumor has it pornographic films were sent with cosmonauts to the space station *Mir*. Russian psychologists recommended viewing them to relieve, ahem, boredom only during the late stages of the stay in space. Until then, they would presumably read Pushkin and Dostoevsky.

The good thing about masturbation is that you don't have to dress up for it.

—*TRUMAN CAPOTE, U.S. writer*

4. DON'T KISS; DON'T TELL. It's been hinted by tattletale Russian technicians that a female cosmonaut on the 1982 *Salyut-7* mission, Svetlana Savitskaya (the second woman in space), docked with certain crew members. No comment from officials. Savitskaya married an Ilyushin aeronautics engineer, had a baby, and retired from flight duty.

Discretion is nothing other than the sense of justice with respect to the sphere of the intimate contents of life.

—*GEORG SIMMEL,*
German sociologist

This item from *The Guardian*'s Jon Henley in Paris, Thursday, February 24, 2000:

U.S. and Russian astronauts have had sex in space for separate research programmes on how human beings might survive years in orbit, according to a book published yesterday. Pierre Kohler, a respected French scientific writer, says in *The Final Mission: Mir, The Human Adventure* that the subject is taboo both at NASA and at mission control in Moscow, but that cosmic couplings have taken place.

5. WELL, IT'S A START. Anecdotal stories suggest that erections take place in space, although public depiction of their quality has not emerged from secretive NASA. Presumably microgravity causes them to be less firm, throbby, or durable than earthly stiffies.

How can we expect another to keep our secret if we have been unable to keep it ourselves?

—*FRANCOIS DE LA ROCHEFOUCAULD,*
French dramatist

Information about clitoral and vaginal arousal is unavailable, but it seems reasonable to expect women's equipment to continue operating, just as with their male colleagues. NASA could presumably monitor this, like other physiological activities, while crews sleep.

What happens in space stays in space. Or does it? For reasons of security as well as scientific inquiry, astronauts are under close surveillance 24/7, aside from brief stops in the toilet—a supremely unromantic location that's cramped even for one. Any intimate liaison would be truly uncomfortable, lightning quick, and probably driven by heightened desperation or lust.

I believe in a zone of privacy.

—HILLARY CLINTON, U.S. senator

6. DRY RUN? NASA consultant G. Harry Stine, who died in 1997, said that the neutral buoyancy tank used for astronaut training at Marshall Space Flight Center in Huntsville, Alabama, was also used, both officially and unofficially, to see whether people could copulate without the assistance of gravitational pull.

But who supervised the tests? Was grading done on the honor system? Was everyone marked on a curve?

7. NOTHING GOOD IS EVER EASY. Physically accomplishing sexual intercourse in space will be as great a challenge as finding the right time and place. Weightlessness places huge demands on the human body—starting with overcoming the urge to vomit.

The microgravity . . . that we have up in space forces some changes in different processes. It forces changes in us as human beings.

—LAUREL CLARK,
U.S. astronaut (died on shuttle Columbia)

Is it even doable? The physiology of sex is affected by the lack of gravity. Impaired blood circulation will likely result in erectile dysfunction (and less arousal for both sexes). Ventilation problems will contribute to heavy perspiration and dehydration.

Any escaping bodily fluids would become unromantic droplets and globules floating around the chamber. Body stabilization and positioning will be a problem. In microgravity there is no up or down, and bodies tend to bounce off each other. Velcro anchoring, connectable body suits, and other props and accessories may be necessary to accomplish anything resembling sexual coupling.

On the psychological side, little is known about mid-term or long-term human reactions to the sense of deprivation, isolation, and confinement; awareness of background radiation; temperature extremes; and a constant underlying sense of danger. At literally any minute, a life-threatening situation could develop. How do these factors affect sexuality?

Among the physiological effects of space flight is the disorientation of bodily fluids, especially blood, which tends to concentrate in the head and thoracic cavity. As the cardiovascular system adjusts to zero gravity, the body uses less blood volume, and the heart doesn't have to work against gravity, so cardiac muscles (and muscles in general) slacken. Unless astronauts exercise vigorously and regularly, they lose muscle tone and undergo general physical deterioration. Gravity is our natural gym. Anything that affects our overall conditioning also affects our sexual performance, so space travel is inherently inimical to lovemaking.

8. NOT THIS MISSION, HONEY; I HAVE A HEADACHE. It is rumored that on space shuttle *Endeavour STS-47*, in September 1992, husband-and-wife astronaut team Mark Lee and Jan Davis tested a number of sexual positions and found that several, including the "missionary position," were next to impossible in zero gravity without an elastic belt, an inflatable tunnel, or presumably the help of an independent third party. This remains conjecture. The honeymooners, now divorced, continue to refuse any comment on their off-duty activities.

It's pure physics. Interpersonal docking requires restraints. Campers on Earth master the use of two-person sleeping bags; what's confinement on the ground may be much more welcome in microgravity. Supposedly an inventor has patented a "Belt to Paradise" designed to enable sexual intercourse in space. And Elaine Lerner, a New England Sunday School teacher, has created a padded harness that one or both sex partners can wear around the hips to permit interplanetary ecstasy.

We live in a culture that is historically uneasy with the subject of sexuality, possibly coming out of our puritanical roots.

—*MERCEDES RUEHL, U.S. actress*

Attention, lovers. During your first days in zero gravity you will suffer from "rocket lag." Your energy will be way down, and you may be nauseated while your body adjusts to weightlessness. Not ideal for eroticism.

A romantic cocktail is out of the question. Mixers won't work. Air bubbles have nowhere to go—there's no gravity to force them to the surface. And you'll have stomach gas. Unromantic, and hard to disguise.

Your bunk is a bad choice for lovemaking. Any bumping and grinding would create an equal and opposite reaction—you'll be bouncing off the walls. Unless at least one partner has restraints, your passionate interlude will look even clumsier than it does on Earth.

9. IF CONCEPTION IS POSSIBLE, IS IT ETHICAL? Gravity is needed for embryonic development. In weightlessness, physiologists estimate a decrease of 15% to 17% in fetal muscle mass, bone deficit, and uncertainty about organ development in the first trimester, when most birth defects originate. After birth, normal developmental stages (sitting, standing, walking) might be delayed. More troubling, critical neural connections could be impaired in weightlessness.

Every human in history has been conceived and born at 1 gravity. Unless we can reproduce that 1-gravity environment at least part of the time in space, humanity may not be able to reproduce effectively. This is a critical issue for the future of our species, assuming our destiny is to colonize other planets.

If the human species . . . is to continue to survive, it must eventually leave the Earth and colonize space. For the simple fact of the matter is, the planet Earth is doomed . . . the Earth should be regarded as the womb of life—but one cannot remain in the womb forever.

—*FRANK TIPLER, U.S. educator,*
The Physics of Immortality *(1994)*

10. SAFE SEX IN SPACE? Although disease is not the main concern here, effective contraception will be a requirement

for long space missions that include heterosexual couples. Pregnancy in space is a serious problem. It impairs the mother's ability to function, and it carries grave risks for fetal development.

NASA says it won't happen. Yeah, so why have they stocked the International Space Station with pregnancy testing kits? As noted above, there is disagreement as to whether conception can or should occur in microgravity. Because of ignorance of its effects on embryos, female astronauts will be forbidden to fly while pregnant.

It should be noted that transmission of disease in a space vessel would not be limited to sex partners. In a totally closed atmospheric system, any infected drop of moisture, hair follicle, or skin cells will circulate through the ventilation system. So there is always risk of spreading disease.

It has become appallingly obvious that our technology has exceeded our humanity.

—ALBERT EINSTEIN, German scientist

11. INDEPENDENT RESEARCH. In a 2000 paper, "The Psychological and Social Effects of Isolation on Earth and in Space," Peter Pesavento interviewed scientists, psychologists, astronauts, and cosmonauts. With the information he gathered, he explored the ways people can and possibly do handle themselves (and maybe others) during extended space missions.

Pesavento focused his article on what he says is "the largest challenge of long-term space flights"—the need to have people return from missions in acceptable emotional and physical health.

In *Quest*, Professor Stephen Johnson of the University of North Dakota said that Pesavento's paper raised crucial issues for the future of humankind in space. "Sexuality and gender relations are just one of several topics that the author addresses, all of which have been issues in human space flight in the past, and will be again in the future," Johnson said.

12. MORE THAN ENOUGH TIME. A U.K. expert said it will be possible to have sex aboard Burt Rutan's privately developed *SpaceShipOne*, since the cabin is pressurized. But participants will be pressed for time, since the craft is out of the atmosphere for a mere 2 minutes. And there's little privacy. Come on—is it really all that urgent?

13. OK, I'LL COMPOSE OPERA INSTEAD. Italian researchers found that levels of the sex hormone testosterone are temporarily lowered in male astronauts, along with a decrease in sexual drive. Hormone levels return to normal soon after re-entry, but scientists are mum regarding return to pre-flight sexual performance levels. (See the chapter on Space Disasters.)

The European Space Agency published another study showing that space flight reduces testosterone levels in male astronauts.

I think that testosterone is a rare poison.

—*GERMAINE GREER,*
Australian activist

14. YEAH, SEX MEANS TROUBLE. As a precaution, NASA officials have been reviewing psychological assessments of

astronauts since the (now former) astronaut Lisa Nowak was arrested for allegedly attempting to harm a female U.S. Air Force captain who was her rival for the affections of a male astronaut.

Being with an insanely jealous person is like being in the room with a dead mammoth.

—MIKE NICHOLS, U.S. director

15. VACANCY. Gene Myers, president of the California-based Space Island Group, is attempting to develop the first space hotel. He spoke about the idea to students of the Rochester Institute of Technology, which offers a course in space tourism. But can hotels flourish if sex is difficult to accomplish in zero gravity? Surely they can't depend exclusively on senior citizen and church group tours for profits. This demands a rotating artificial-gravity environment.

In 2001: A Space Odyssey, *Stanley Kubrick and I depicted a commercial space plane delivering passengers to a huge, wheel-shaped space station. Commercially operated hotels, restaurants, and videophone booths were plentiful on board. Stanley and I firmly believed that commercial stations would offer the citizens of Earth far greater access to space than government-run programs. I still believe that today, which is why I'm supporting the space island group.*

—ARTHUR C. CLARKE, British scientist and author

16. WHADDYA GONNA DO—WALK HOME? There was an attempted sexual assault during a lengthy simulated *Mir* mis-

sion at the Institute for Biomedical Problems in Moscow. Alcohol was involved (it was New Year's Eve). A Russian crewman tried to kiss an unwilling Canadian female researcher, just after two other Russians had been in a bloody brawl. What a party. Locks were later installed between the Russian and international crew compartments.

Sexual harassment, already a big problem in the coed military, could become a problem in space, where stressful conditions and the possibility of antisocial behavior are constantly present.

A major hurdle in women's acceptance into the astronaut corps was overcome by the development of private toilets for use aboard the space shuttle. Previously, the lack of privacy, essential to hygiene (and incidentally to sexual activity), had been an element in (or perhaps an excuse for?) NASA's reluctance to accept women for space assignments. Gentlemen are, after all, gentlemen. The simple addition of the private powder room enabled the agency finally to include ladies on shuttle missions.

But the potential for trouble remains as long as there are boys and girls.

With sexual harassment, one always thinks of the man as the harasser, not the woman.

—VICTORIA ABRIL, Spanish actress

Cultural issues are also in play. One anecdote tells of a Muslim passenger on an all-international crew spaceflight who had to take directions from a higher-ranked woman. Whenever she addressed him, he ignored her, because his cultural heritage prohibited such contact between men and women. As a result, directions had to be given by the woman to a male colleague, who repeated them to the Muslim man, who then carried them out cheerfully and efficiently.

17. HEY DOC, I DON'T FEEL SO GOOD. There is little research on how human sexual activity (or lack thereof) relates to depression, listlessness, sleep disorders, fatigue, cognitive deficit, irritability, hostility, or other aspects of personality impairment.

18. KEY PARTY, ANYONE? Paul Root Wolpe, a University of Pennsylvania bioethics advisor for NASA since 2001, says, "There is a decision that is going to have to be made about mixed-sex crews." How mixed? Male and female, gay and straight, all-married crews? And on super-long (eventually colonization) trips, will partner swapping be allowed in the interests of ensuring a varied gene pool?

It's easy to sleep floating around—it's very comfortable. But you have to be careful that you don't float into somebody or something!

—SALLY RIDE, U.S. astronaut

On the International Space Station, conflicts are likely if women and men are perceived as unequal in status. Also, trouble is a sure bet if some sex is going on, but some of the crew are deprived while others are getting their share. (This scenario has been noted during expeditions to Antarctica and other remote places.)

19. CAREFUL THERE, SAILOR. Homosexual activities are less likely to have occurred in space than heterosexual activities. Assuming there are gay astronauts, the majority of their colleagues—mirroring the general population—are probably

heterosexual. Disclosure of homosexual acts, in space or elsewhere, would likely end their careers.

Among men, sex sometimes results in intimacy; among women, intimacy sometimes results in sex.

—*BARBARA CARTLAND,*
British novelist

Homosexual sex could have already occurred. People tend to find one another through conscious or unconscious cues. If closeted or unaware potential homosexual partners happen to be training intensively for a mission, they might give in to their attractions when the opportunity arises far from home.

It doesn't matter what you do in the bedroom as long as you don't do it in the street and frighten the horses.

—*DAPHNE FIELDING, British author,*
The Duchess of Jermyn Street

20. LURING THE FARM BOYS. Vladimir Zhirinovsky, a Russian politician, proposed sending prostitutes to space (and to military installations and prisons) to relieve stress among Russia's hard-working astronauts.

It seems inevitable that the "oldest profession" (at least, the oldest freelance profession) will be a part of pioneer space settlements once non-governmental and commercial activities take root on other planets and space stations. This is not likely until late in the twenty-first century or perhaps later, and will probably emerge as a feature of the tourism industry.

* * *

DOES OUT-OF-THIS-WORLD SEX HAVE A FUTURE?

If our long-term survival is at stake, we have a basic responsibility to our species to venture to other worlds.

—CARL SAGAN, U.S. astronomer

Assuming that humanity is destined to spread among the stars, what options will we have if sexual reproduction proves unwieldy or results in deformed or dysfunctional offspring? Cloning? Suspended animation? Artificial gravity vessels for colonization? Artificial worlds? Humans are inventive, so—if we can hold out long enough on this troubled planet—we will eventually find or create ways to carry our seed safely elsewhere in the universe.

An interesting legal issue suggests itself. If your children are born in outer space, are they citizens of Earth, where their genes originated? Do they inherit your nationality? Or are they citizens of the mini-world in which they were born? Are they natives of NASA, or are they—by definition—space aliens?

The Earth is just too small and fragile a basket for the human race to keep all its eggs in.

—ROBERT A. HEINLEIN,
American science fiction author

20 THINGS YOU DIDN'T KNOW ABOUT SLEEP

Sleep that knits up the ravell'd sleave of care, The death of each day's life, sore labour's bath, Balm of hurt minds, great nature's second course, Chief nourisher in life's feast.

—*WILLIAM SHAKESPEARE,*
British playwright, Macbeth

We might suppose that something as basic as sleep would be as easily accomplished as eating, drinking, breathing, and other life essentials. That's not always true, as anyone will attest who suffers from a sleep disorder.

We might also expect that by now we'd understand exactly what sleep is, how it happens, and how to make it everything we'd like it to be.

Not a clue. Well, maybe a clue or two.

Since we spend roughly a third of our life in an asleep state, we might as well benefit as much as possible from it. Rest time is time well spent for physical and mental repair. Cells grow and develop, tissues proliferate, bodily wastes accumulate for elimination (preferably after awakening). Sleep slows physiological processes. Blood pressure, respiration rate, and temperature fluctuate according to which stage of sleep we're in.

But although we can describe sleep, its whys and wherefores remain incomprehensible. Sleep is a foreign country flush with delightful dreams or horrific nightmares, an inexplicable dimension suspended between reality and phantasm.

* * *

1. SLEEP IN A NUTSHELL. Ideally, sleep is a nightly event lasting several hours, with body and mind in restful self-repair. Eyes close. Unconsciousness results, with reduced body movement and little or no awareness of—or responsiveness to—the world outside. When humans snooze, characteristic brain-wave patterns indicate the various stages of sleep. Healthy sleep includes intervals of the mysterious phenomenon we call dreaming.

If I didn't wake up, I'd still be sleeping.

—YOGI BERRA, U.S. Baseball Hall of Famer

Sleep is a rest cycle regularly present, in one form or another, in most living species. It is reversible unconsciousness (every time but one), triggered by a constellation of hormones responding to signals from the body and its environment.

It comes upon us in stages, each with its own recognizable brain wave "signature." Brain waves are measured in cycles per second (CPS). When you are completely awake and alert, your brain is cranking out 14 CPS or more. These are beta waves—the waves you surf while solving problems or making decisions, the wavelength of consciousness and concentration.

Nothing interferes with my concentration. You could put on an orgy in my office and I wouldn't look up. Well, maybe once.

—ISAAC ASIMOV, U.S. scientist

2. YOU KNEW THIS, RIGHT? Adult humans generally function best on 8 hours of sleep a night (or day, depending upon lifestyle). Some require more; others function perfectly well with less. Women appear to need more sleep than men. Clinical evidence shows that children, especially teenagers, may need 9 to 10 hours for best results at cheerleader tryouts and for impressive SAT scores.

The amount of sleep required by the average person is five minutes more.

—WILSON MIZENER, U.S. writer

One of the longest recorded sleepless stint dates back to 1964, when San Diego high school student Randy Gardner, supervised by Stanford University scientists, stayed awake for 264 hours and 12 minutes—a bit more than 11 days. It was previously believed that going without sleep for so long would cause serious mental damage. That proved untrue for Randy, who sacked out for 15 hours, then returned to his normal waking/sleep schedule with no noticeable aftereffects.

3. NOT ENOUGH Z'S IN THE USA? According to the National Sleep Foundation, nearly three fourths of all Americans feel

they don't get enough sleep, a third have trouble sleeping every night, half need an alarm clock to awaken, over half report sleep problems a few nights a week, and most expect to feel groggy during the week. People with sleep problems are twice as likely as good sleepers to feel stressed and generally run down.

Most adults have a hard time getting started in the morning. Our average nightly sleep has declined in two decades to just under seven hours. It's often less for parents of young children, who average about an hour less per night than other adults.

Seven beers followed by two Scotches and a thimble of marijuana, and it's funny how sleep comes all on its own.

—*DAVID SEDARIS, U.S. writer*

4. INSOMNIA HAPPENS. According to the National Institutes of Health, more than 70,000,000 people in the U.S. have trouble sleeping, and it's chronic for about 60% of them. Women are twice as likely to be insomniacs.

This is not good news, because sleep is intimately linked to our immune system. Undersleeping can cause an immune response similar to infection. Sleep deprivation often results in psychic damage as well as diminishment of perceptual faculties and intellectual processes.

The worst thing in the world is to try to sleep and not to.

—*F. SCOTT FITZGERALD, U.S. novelist*

Insomnia is often linked to anxiety, depression, and sometimes substance abuse. Whatever the root cause, some

systems in the brain fail to shut off, as they do in normal sleep.

The best cure for insomnia is to get a lot of sleep.

—W. C. FIELDS, U.S. comedian

Childhood insomnia is a strong indicator of subsequent alcohol and drug abuse. Impaired sleep in early childhood translates into double the likelihood of drug problems in the teen years. And in a 2004 study by the University of Michigan, 43% of adult respondents reported that daytime sleepiness interfered with their daytime activities, including work.

It is estimated that between 30% and 40% of commercial truck accidents and 100,000 automobile crashes are due mainly to driver fatigue.

If you can't sleep, then get up and do something instead of lying there worrying. It's the worry that gets you, not the lack of sleep.

—DALE CARNEGIE,
U.S. self-improvement impresario

Insufficient sleep is linked to illness, including diabetes, hypertension, psychosis, and mental decline. But even insomnia can occasionally confer side benefits for artistic creators, writers on deadline, and others who are able to work with fewer distractions while the world slumbers.

Life is something that happens when you can't get to sleep.

—FRAN LEBOWITZ, U.S. comedienne

Sleep problems are reaching epidemic proportions, estimated to be the No. 1 health-related problem in America.

—REPORT ON CNN, May 1997

5. WAIT! HERE'S A DISSENTING VIEW. Is the "sleep problem epidemic" a boondoggle designed by the sleep medication industry? Psychiatry Professor Daniel Kripke of the University of California at San Diego thinks so. He contends that the shrilling about Americans being "sleep-deprived" originates in the boardrooms of the drug industry, whose products are vacuumed up by scared Americans to the tune of billions of dollars a year.

Other entities have a financial interest in scaring people awake. Kripke points to millions of dollars a year doled out for sleep research. Yet, a 6-year study of more than 1,000,000 adults, reported on the LiveScience Web site (3/23/2006), makes this startling claim: "People who get only 6 to 7 hours a night have a lower death rate than those who get 8 hours of sleep."

While the controversy boils, the same Web page offers this advice to anyone concerned about sleep deficiency, real or imagined:

Don't take sleeping pills of any kind, including melatonin and other so-called "natural" supplements.

Don't go to bed until you really feel sleepy.

Get up at your usual time in the morning, even when you still feel sleepy—you'll be ready to sleep by nightfall.

If you wake up in the middle of the night and can't sleep, get up and do something until you feel sleepy again.

And finally, stop worrying. Watch TV, read, listen to re-

laxing music (but don't disturb the neighbors). You'll probably be fine.

Nothing cures insomnia like the realization that it's time to get up.

—AUTHOR UNKNOWN

The breeze at dawn has secrets to tell you;
Don't go back to sleep.

You must ask for what you really want;
Don't go back to sleep.

People are going back and forth across the doorsill
Where the two worlds touch.

The door is round and open.
Don't go back to sleep.

—RUMI, Afghan poet

6. THE SLEEPER'S HOROSCOPE. Professor Chris Idzikowski, director of the U.K. Sleep Assessment and Advisory Service, analyzed six common sleeping positions and theorized that each is linked to a particular personality type. Can you match the following to your zodiac sign? Maybe you're a Leo who sleeps like a Pisces.

Womb Dwellers (41%) curl up in the fetal position. They are "tough on the outside but sensitive at heart." Shy when they first meet somebody, they soon relax. This is the most common sleeping position; more than twice as many women as men sleep this way.

Log Persons (15%) lie on their side, arms down. They tend to be easygoing and sociable, in with the "in-crowd," trusting but sometimes easily hornswoggled.

Yearners (13%) sleep on their side with both arms in front. They have an open nature but can be suspicious and cynical. They are slow to decide, but once they do, they are unlikely ever to change.

Soldiers (8%) lie on their back with arms pinned to their sides. They are generally quiet and reserved, and they set high standards for themselves and others.

Freefallers (7%) lie on their front with hands around the pillow, head to one side. Often gregarious and brash, they can be nervy and thin-skinned underneath. They dislike criticism or extreme situations.

Starfish (5%) lie on their back, both arms up around the pillow. They make good friends, are always ready to listen to others, and offer help when needed. Generally they don't like to be the center of attention.

Other respondents said their sleeping position varied, or they did not know. When Professor Idzikowski examined how sleeping positions affect health, he concluded that Freefall was good for digestion but that the Starfish and Soldier positions were likely to lead to snoring and bad sleep.

7. SLEEPGATE. Not a scandal about politicians sleeping around. A "sleep gate" is a window of opportunity during which your body is primed to let you sleep. Your brain goes through several sleep cycles each night, each lasting from 90 minutes to 2 hours. At the beginning of each cycle, the "sleep gate" opens and lets you fall asleep. The ability to fall asleep is

linked less to how tired you are than to how long it's been since your last sleep gate.

Brain chemistry has still not given up all its secrets. From time immemorial, artistic insights have been revealed to artists in their sleep and in dreams, so that at all times they ardently desired them.

—PARACELSUS, Swiss scientist

8. WHILE YOU WERE SLEEPING. More disturbing than sleepwalking or sleeptalking is "sleep sex," as researchers call sexual acts performed on themselves or others by "unconscious" people. Ranging from honeylipped murmurs and caressing to unwanted, even forcible, intercourse, perpetrators awaken with no memory of the event.

In Australia a doctor has discovered a female patient whose sleepwalking causes her to go out and have sex with total strangers while she's asleep. They could have diagnosed this years ago, but no guys ever complained.

—JAY LENO, U.S. comedian

Stanford University scientists believe that "sleep sex" episodes are triggered by glitches in the sleeper's brain waves—"hiccups" in the normal sleep cycle. Mild episodes can be merely embarrassing and go unreported, even to the offending partner. But when things turn violent—one man attempted to strangle his wife during a sleep sex episode—help is clearly a must. Beyond the sleep disorder aspect, such people may have severe underlying emotional problems that need intensive study and treatment.

Somniphobia is the fear of sleep. Many people who suffer from anxiety, or who are subject to panic attacks, dislike bedtime and fear the prospect of "surrendering" to sleep, which they fear renders them vulnerable to harm or even death. The symptoms are like those of other anxiety disorders: difficulty breathing, dry mouth, sweaty palms, palpitations, muddled thinking, trembling, and so forth.

Treatment options include psychotherapy, supervised medication, and hypnosis. Far from being something "silly" that the sufferer should just "get past," somniphobia is a condition to be taken seriously.

I'm afraid to sleep. It's a form of death.

—EDITH PIAF, *French singer*

I never sleep, 'cause sleep is the cousin of death.

—NASIR JONES, *U.S. rapper*

You can't stay married in a situation where you are afraid to go to sleep in case your wife might cut your throat.

—MIKE TYSON, *U.S. boxer*

9. MAYBE RESTING IS ENOUGH. Despite years of tradition presenting sleep as bodily R&R, little evidence suggests that our organs, other than the brain, undergo exceptional repair during sleep. The liver, heart, intestines, and muscles undergo tissue and cell restoration equally well (possibly even better) during relaxed wakefulness.

Tissue repair is stimulated by increased amino acid levels in the blood, following food absorption in the gut. These amino acids are scooped up by cells and synthesized into new proteins that replace worn-out proteins. Besides water,

tissues are mainly protein. Tissue repair is facilitated by physical rest, but it does not necessarily have to be sleep.

Basically, I'm for anything that gets you through the night—be it prayer, tranquilizers, or a bottle of Jack Daniels.

—*FRANK SINATRA,*
the original American Idol

10. LET US NOW PRAISE CATNAPS. Scientists theorize that a quick afternoon nod-off may have the effect of creating two productive work days out of one. Sleep experts believe that we should all "power down" a few minutes a day. Recent studies in the U.K. suggest that catnaps improve productivity and boost morale in a society that feels increasingly sleep deprived.

World leaders like JFK and Ronald Reagan claimed that catnapping charged their batteries during hectic times. Winston Churchill credited catnaps with his ability to lead the U.K. through World War II on barely 2 hours of sleep a night for several years. (The role of brandy and cigars is still a matter of debate.) Edison, Einstein, da Vinci, Brahms, and other geniuses were also big siesta fans. Napoleon was capable of catching a refreshing snooze even as artillery roared around him.

But the important thing is to lie down and fall asleep. That little nap means you wake up fresh again and can continue.

—*JAMES LEVINE,*
U.S. orchestral conductor

There is more refreshment and stimulation in a nap, even of the briefest, than in all the alcohol ever distilled.

—*OVID, Roman poet*

11. LIFE IS A DREAM. The objective dimension of sleep concerns body repair and physical issues. But sleep's truest mystery—besides why it exists at all—is that mysterious subjective dimension we call dreaming. We can map dreamers' brain waves, theorize about "wishes the heart makes," and discuss repressed desires—all of that. But we have no idea what dreams are, why we have them, or why dream deprivation has serious psychic consequences.

I experience a period of frightening clarity in those moments when nature is so beautiful. I am no longer sure of myself, and the paintings appear as in a dream.

—VINCENT VAN GOGH,
Dutch painter

A dream which is not interpreted is like a letter which is not read.

—THE TALMUD

Myths are public dreams; dreams are private myths.

—JOSEPH CAMPBELL,
American mythologist

12. THY DEEP AND DREAMLESS SLEEP. About 80% of sleep is dreamless and is known as non-rapid eye movement (NREM) sleep. The four generally accepted stages of sleep are defined by their increasing depth.

Level One is the dreamy transition period between sleep and wakefulness. Level Two is characterized by major relaxation of heartbeat and breathing (this level is about half of all sleep time). At Levels Three and Four, we're deep into delta waves, zoned out. Rapid eye movement (REM) sleep occurs

at intervals of 1 to 2 hours, usually in four or five episodes. REM sleep—up to 25% of sleep time—is characterized by irregular breathing and accounts for most of our vividly recalled dreams.

But what is all this fear of and opposition to Oblivion? What is the matter with the soft Darkness, the Dreamless Sleep?

—*JAMES THURBER, U.S. writer*

13. DROWSY DRIVING. Tired drivers are accident prone. Judgment is impaired, leading to mistakes and bad decisions. Researchers find that 24 hours without sleep translates to reduced hand-eye coordination, equivalent to a blood alcohol content of 0.1. Besides road accidents, sleep deprivation contributes to workplace injuries and poor school performance, and it is surely an element in mental health problems and everyday depression.

Many accidents that involve sleepy people who have also been drinking are mistakenly attributed solely to the effects of alcohol, since our system monitors drunk driving but not drowsy driving. The symptoms are not very different: lack of attention, impaired judgment, sluggish reflexes, a feeling of unreality, and time distortion.

Studies by the Institute of Medicine in the 1990s estimated the cost of treatment of sleep disorders at nearly $16 billion. This does not include an additional $150 billion in losses to business caused by employee fatigue, reduced productivity, and sleep disorder–related accidents. Damages caused by overtired drivers amounted to at least $48 billion a year.

Volvo is producing a vehicle for 2008 that is designed to wake drivers before they fall asleep at the wheel. Cameras monitor the driver's eyes and head and the road. Sensors are programmed to react to jerky movements of the steering wheel or the driver. If the system "sees" the driver looking away from the road too often or too long, it triggers a wakeup alarm sequence.

14. SLEEP YOURSELF SKINNY? Sleep is essential to a healthy immune system. It also keeps appetite mechanisms in balance by regulating two hormones (ghrelin, an appetite stimulant, and leptin, an appetite regulator) that control feelings of hunger or fullness. When lack of sleep gets them out of whack, the imbalance can lead to weight gain.

There are many causes of sleep deprivation.

Many people simply choose to stay up later than they should (especially kids and teenagers) because it's perceived as "cool." They don't realize they need more sleep, and late hours and groggy mornings simply become a habit.

Illness and sleep disorders can result in fragmented sleep—apnea (breathing irregularities), snoring, constant waking, gagging, etc. Ironically, many medications contribute to insomnia, even to the thrashing about caused by "restless leg syndrome."

Occupational factors claim their share of victims—shift workers whose circadian rhythms are constantly changing; frequent travelers such as airline crews and military personnel.

Sleep is often impeded by the sleeping environment itself: a bedroom that is too hot or too cold, an uncomfortable bed or pillow; noisy neighbors, or a snoring person inches from your ear. Every new parent experiences baby-related wakings: Is she still breathing? Was that a cough?

Personal habits ("poor sleep hygiene") can prevent a good night's sleep. Drinking coffee or alcohol, or smoking cigarettes just before bedtime, can overstimulate the nervous system.

Finally comes the age-old problem of worrying, going to bed angry, or thinking about work, finances, or personal issues. For most people this may be the hardest sleep disorder to treat.

To improve your sleep life, try these.

Go to bed earlier each night. Avoid smoking, booze, and caffeine (coffee, colas) near bedtime. Upgrade your sleeping environment. Wear earplugs if your partner snores or you live in a noisy neighborhood. Use any cornball New Age relaxation technique that seems to work. If none of these work, go for professional help.

If I feel in need of sleep, I just open a book or turn on the television. Both are better than any sleeping pill.

—ETHEL MERMAN, U.S. singer

15. PILLS, TABLETS, CAPSULES, WHATEVER. Americans adore medications. Sleep aids are no exception. In 2006, some $2 billion was spent on sleeping pills—prescription and over-the-counter. (In 2004 alone, about 35,000,000 prescriptions were written for sleeping pills!) Senior citizens are top poppers; women in general are more avid users than men. In just 4 years, sleeping pill gobbling among people 20 to 44 years old has doubled.

A 2002 sleep study at Oxford University revealed that counting sheep is not an effective measure against insomnia. Turns out it's too boring, so the mind keeps returning to

thinking about whatever was keeping the patient awake in the first place.

16. THE UN-SLEEPING PILL. A drug called Modafinil, concocted to shut off the sleep reflex, has been tested on healthy subjects, including airline pilots. Subjects can stay awake and alert, functioning at high levels, for 2 straight days, needing only an 8-hour sleep before repeating the 40-hour waking cycle, with no apparent decrease in abilities or other ill effects.

Modafinil was developed originally to treat narcolepsy, in which sufferers suddenly fall asleep uncontrollably and often. Unlike most anti-narcoleptic medications (or stimulants like amphetamines and cocaine), Modafinil seems to deliver no rebound, crash-and-burn, or paranoid reactions. Beyond its use for narcoleptics, the drug seems to have practical applications for military in the field, emergency workers, and others who must remain alert and functional for extended periods under stressful conditions.

The Air Force is conducting experiments to see whether its personnel can perform well up to 88 hours without combat fatigue—or getting the jitters or dry heaves.

I never drink coffee at lunch. I find it keeps me awake for the afternoon.

—RONALD REAGAN,

40th U.S. president

17. THE UNBREATHING. More than 18,000,000 Americans suffer from sleep apnea—the interruption of normal breathing for 10 seconds or more while asleep. This potentially dangerous disorder, left untreated, can lead to heart

and respiratory problems or even death by stroke or cardiac arrest.

Overt symptoms of sleep apnea are excessive snoring, gasping, and choking (sometimes bolting out of a deep sleep). Deeper symptoms may include high blood pressure and lowered metabolism (and consequent obesity). For men, getting up frequently at night to urinate, besides suggesting an enlarged prostate gland, could signal the presence of sleep apnea, as might sudden decreased libido or erectile dysfunction.

18. SOAKED SHEETS. Bedwetting, known medically as nocturnal enuresis, afflicts an estimated 5 million to 7 million children in the U.S. on a regular basis.

At a recent national convention of the American Academy of Pediatrics, 300 doctors and nurses participated in a seminar called "Evaluation of the Wet Child." A survey revealed that 23% of those present at the discussion had themselves been bedwetters as children. So they were closely familiar with the problem.

Actors Michael Landon and Suzanne Somers both wet their beds nearly every night until age 14. Because of his polio disability, President Franklin Roosevelt suffered from urinary incontinence and wore diapers. But incontinent presidents constitute a chapter for some future volume.

19. ODD INSECT SLEEP HABITS. Some bees (for example, males of the Apidae family) bed down by clamping their jaws

on to a leaf, then folding up their legs. They dangle by the mouth until dawn. They tend to use the same "bed" night after night, presumably able to find it because of the personal scent they sprayed there.

Really scary is the Weta cricket from New Zealand, native to high altitudes. Each night it shuts down and freezes solid until morning, when it thaws out for the day's cricketing. Nightly hibernation in a very real sense.

Researchers verify sleep in animals by recording brain waves. But microscopic electrodes are in short supply, so much has to be inferred through other means.

Insects seem to sleep. They are less active at low temperatures, and at times they appear comatose or in a state of torpor. Day-active bugs quiet down at night. When migrating, monarch butterflies collect in large groups at dusk, fold their wings, and appear to rest before continuing at dawn. Dragonflies are less alert and easier to catch after sundown.

20. DOES THE MACKEREL DREAM? And if so, of what? Most fish enter an energy-saving state we might identify as sleep, but it's not like ours. Bass, perch, and catfish rest under logs at night, as do other species of day fish that seek out cracks in rocks to avoid becoming dinner for species of night fish.

We measure mammal, reptile, and bird sleep by checking changes in their brain wave patterns. But whatever fish sleep is, it presumably recharges their bodies.

Minnows, "day schoolers," split into small groups and remain motionless at night. Herring and tuna sleep at night. But no matter how tired they are, they never close their eyes. They can't. No eyelids.

Some aquatic animals, like sharks, never stop swimming because they must keep moving to force water through their gills to breathe. Mammals like whales and dolphins are conscious breathers, so they have to sleep with one eye open, like many university undergraduates.

* * *

SWEET DREAMS, EVERYONE

And so the mystery continues, far beyond anything we can present here. Why is there sleep? Why are there dreams? Why does sleep come in so many forms, with so many aberrations? How can we consciously study unconsciousness? This is a dilemma that scientists have been trying to probe since humanity first became conscious of being conscious.

Now, blessings light on him that first invented sleep! It covers a man all over, thoughts and all, like a cloak; it is meat for the hungry, drink for the thirsty, heat for the cold, and cold for the hot. It is the current coin that purchases all the pleasures of the world cheap, and the balance that sets the king and the shepherd, the fool and the wise man, even.

—*MIGUEL DE CERVANTES,*
Spanish novelist

20 THINGS YOU DIDN'T KNOW ABOUT SPACE DISASTERS

Exploration really is the essence of the human spirit, and to pause, to falter, to turn our back on the quest for knowledge, is to perish.

—FRANK BORMAN,

U.S. astronaut

Colonel Borman is right. But it's also true that facing the quest for knowledge can mean perishing—not as a society, but as individuals.

Since the first days of the space age, our machines have become unbelievably powerful. They work at astronomical speeds and pressures, with dinky margins for error. When they go wrong, they tend to go catastrophically wrong. And when that happens, we lose some of the most gifted people on Earth: men and women of nearly superhuman physical and mental conditioning. Bold people with hyper-fast problem-solving ability; capable of troubleshooting, repairing, and replacing unique high-tech equipment—sometimes even refashioning it under emergency conditions.

Picture these people inside their cramped vessel, exploding off the ground with unimaginable, potentially lethal force . . . going merrily off to work. Their job? Inventing the future.

You're really taking an explosion and you're trying to control it. You're trying to harness that energy in a way that will propel you into space. And we're very successful in doing that. But there are a million things that can go wrong.

—MICHAEL P. ANDERSON,
U.S. astronaut (died on shuttle Columbia*)*

* * *

1. UNHAPPY LANDING. Yuri Gagarin, the first man in space, died when his MIG-15 crashed on a training mission. An outdated weather report was officially blamed. (Rumors that he was drunk proved to be unfounded.) Some surmised that a cockpit hatch was part way open, leading to oxygen starvation. Another possibility is explored below.

I could have gone on flying through space forever.

—YURI GAGARIN, first man in space

2. TATTLE-TALES. Various sources suggest that at least seven, maybe as many as eleven, cosmonauts had perished before Gagarin's 1961 purported flight.

Although Gagarin is the first man "known" to have gone into space and back, rumors have circulated that the USSR had already launched others into orbit. One was Vladimir Ilyushin, son of the Soviet airplane designer. A 2001 Russian TV documentary (*Cosmonaut Cover-Up*) stated that on April 7, 1961, Ilyushin blasted off, had a disastrous first orbit, and was forced to crash land in China. After extensive medical treatment, he was sent home and died in a "car ac-

cident" later that year. Maybe. Dictatorships abhor conflicting stories.

In April 2001, Russian senior engineer Mikhail Rudenko, formerly of the Experimental Design Office, wrote in *Pravda* that three cosmonauts had died in space before Gagarin: Ledovskikh (1957), Shaborin (1958), and Mitkov (1959). Journalist and cosmonaut candidate Yaroslav Golovanov (1932–2003) wrote in *Cosmonaut One* that on November 10, 1960, cosmonaut Byelokonyev died in orbit.

3. DISAGREEING WITH HISTORY. There is another view of the Gagarin story. In his book *Gagarin: A Cosmic Lie*, Hungarian journalist Istvan Nemere says the Gagarin flight was a propaganda hoax.

Nemere reports that by 1961, the U.S. had overcome *Sputnik* shock and orbited 42 satellites, the USSR only 12. When we announced Alan Shepard's first manned space flight for May 5, 1961, the Soviets scrambled to play catch-up. They hastily sent up Ilyushin (see above), who was so badly injured that he couldn't be paraded in public. Although the Americans had intercepted radio chatter between Ilyushin and ground control, they chose to suppress the information.

Radio Moscow broadcast on April 12, 1961, that Gagarin had gone into space aboard *Mostok* and landed safely. Everybody believed this (most still do) except Western intelligence services, which intercepted no traffic between space and the Space Centre on that day.

The newspaper *Sovyetskaya Rossiya* said that Gagarin wore a blue flight suit; in Gagarin's memoirs he claims it was bright orange. A colorblind cosmonaut? At the press conference, Gagarin stated that he had no problems with

weightlessness. Every other astronaut and cosmonaut has reported difficulties adjusting.

When Gagarin claimed (with mission experts at his side) "... then I saw South America," nobody mentioned that such a sighting would have been impossible. At the time he'd have been crossing South America, it was about 2:00 A.M.; he would have seen nothing. Foreign journalists asked when Gagarin's space photos would be published. Gagarin seemed uncomfortable, then stammered "Oh, I didn't have a camera with me!" ... hello?

Even unmanned Soviet space probes carried photo equipment. Why would they miss such a tempting propaganda coup as the first pictures ever taken by a space traveler?

Maybe Gagarin's jet didn't crash but was crashed. The thinking: Gagarin wanted to really travel in space, and he may have threatened to expose the lie if they didn't send him up. So they sent him down. His plane exploded on March 27, 1968, under suspicious circumstances. The official report claimed that there "was not much left of the body"—but that somehow his intact flight suit was found in the top of a tree. Once again, hello?

4. YOU'RE SAFER IN THE ROCKET. As many as 200 people died when an R-16 rocket exploded at the Baikonur Cosmodrome on October 24, 1960. This was kept secret until the Soviet Union collapsed in 1991.

Only those who dare to fail greatly can ever achieve greatly.

—*ROBERT F. KENNEDY,*
U.S. senator

Ever since Robert Goddard's early experiments, since Nazi V-2s began blowing up on the launch pad, and continuing to recent Chinese mishaps, rocketry's most dangerous job isn't flying the craft. It's working the launch pad. The Baikonur catastrophe shows that minor oversights can lead to extremely loud, lethal consequences.

At the highly secret "space city" in what is now Kazakhstan, the second stage of an experimental ICBM accidentally ignited on the launch pad, sending out a 50-foot flare that instantly blew up the main fuel tank of the first stage. Decades of Soviet cover-up have resulted in uncertainty regarding the exact number of casualties, but it was surely many of the 200 or more personnel who typically worked such a launch.

Cause of the disaster? A minor flaw in the second-stage safeguard system. Whenever organizations are pressed for a fast PR victory, safety is likely to take a back seat.

The desire for safety stands against every great and noble enterprise.

—TACITUS, Roman historian

Success in any endeavor requires single-minded attention to detail and total concentration.

—WILLIE SUTTON, U.S. bank robber

5. THE ONLY COSMONAUT TO DIE UNDER A TRAIN. Slated to follow Gagarin into space, G. G. Nelyubov reportedly got into a drunken fight with an army patrol, refused to apologize, and was demoted and airbrushed out of the official cosmonaut team photo. Five years later he committed suicide. Or did he?

Nelyubov was a promising cosmonaut trainee, destined to follow Gagarin into space. But like many test pilots, he

was egotistical and arrogant. After the drunken brawl, when his comrades apologized, Nelyubov became even more abusive. The head officer filed a report with the commander of the cosmonaut corps, a strict old-school disciplinarian. Not wishing Nelyubov's behavior to reflect badly on the corps, he kicked the surly trainee out of the program.

Nelyubov was reassigned to interceptor fighter duty in Siberia. Since the Soviets had expunged all mention of his fight and dismissal, nobody believed that Nelyubov had been a cosmonaut. Even more galling for the egotistic young officer was to stay behind while his former colleagues soared off into space. Sinking into depression and alcohol abuse, in 1966 he walked in front of an onrushing train not far from Vladivostok. It is not known whether it was suicide—or if he was just falling-down drunk.

The first group of Soviet cosmonauts was culled in 1960. Qualifications: candidates had to be military jet pilots under 30 years old, not heavier than 155 pounds or taller than 5'7" because there's not much room in a space capsule. Big guys cost more in fuel and oxygen, and they take up valuable space.

The American space program preferred veteran test pilots; the USSR preferred to train youngsters expressly for space duty—they would have fewer "air pilot" lessons to unlearn.

Of 3,000 applicants who passed the first medical exams, 102 Soviets were selected to go on for physical and psychological tests. This was eventually whittled down to 20. Of that élite, 12 ended up in space. Of the other eight, one died in a training fire, three (including Nelyubov) were expelled for improper behavior, and four were badly enough injured while training to leave the program.

6. CAN'T AVOID THE OBVIOUS. In 1967, Vladimir M. Komarov became the first person who is confirmed to have died on a space mission when parachutes on his *Soyuz* capsule failed to open during descent.

Colonel Komarov was chosen for the first cosmonaut group, the equivalent of our original seven *Mercury* astronauts. Joining the Air Force at 15, he continued to their Engineering Academy. He was the first cosmonaut to travel into space more than once. During his fateful final mission, radio intercepts picked up garbled transmissions from the spacecraft, which some interpret as Komarov cursing the spaceship designers and flight controllers. Based on what happened only minutes later, his angry outburst would have been understandable.

In honor of his life and work, the Soviet Union named a lunar crater, an asteroid, and the military pilot school in Yeisk after him.

Don't you forget what's divine in the Russian soul, and that's resignation.

—JOSEPH CONRAD, Polish-born novelist

7. TRAGIC LITTLE DETAIL. The three crew members of *Soyuz 11* suffocated on June 30, 1971, because of a faulty air valve. So far, they are the only people acknowledged to have died in outer space.

Soyuz 11 ran the gamut from triumph to tragedy. It was the first ship to dock with the world's first space station, *Salyut 1.* During 22 days in space, the crew encountered a series of major problems, which they overcame: a ventilator that needed replacement, a fire that broke out on the 11th

day, and the serious personality conflict between commander Dobrovolskiy and veteran cosmonaut Volkov. Still, the visit was scientifically productive.

However, on June 30, 1971, after a seemingly normal landing, the recovery team opened the hatch and found the crew dead of asphyxiation. CPR attempts failed, as the crew had been dead 15 minutes or more. Analysts concluded that the capsule had suddenly depressurized, probably because of a faulty explosive bolt firing sequence, while in the descent pattern over France.

Only days before the launch of *Soyuz 11,* the mission crew (Leonov, Kubasov, and Kolodin) were replaced by the backup crew (Dobrovolskiy, Volkov, and Patsayev). Flight doctors suspected that Kubasov had contracted tuberculosis. Valeri N. Kubasov (b. 1935) was an engineer cosmonaut, who flew the first docking mission between American and Soviet spacecraft. In 1969 he had flown *Soyuz 6.* He lived to fly again in *Soyuz 19* (1975) and *Salyut 6* (1980). He retired from space duty in 1993.

8. LEARNING FROM MISTAKES? The Soviet (now Russian) space program has not had a fatal accident (that we know of) since *Soyuz 11* in 1971. NASA, however, has lost two of its original four-shuttle fleet, with 14 deaths resulting.

A life without adventure is likely to be unsatisfying, but a life in which adventure is allowed to take whatever form it will is sure to be short.

—*BERTRAND RUSSELL,*
British philosopher

Man is the animal that intends to shoot himself out into interplanetary space, after having given up on the problem of an efficient way to get him 5 miles to work and back each day.

—*BILL VAUGHAN, U.S. journalist*

9. JINXED MISSIONS? Maybe NASA should wait until after Groundhog Day: The fire on *Apollo 1* (January 27, 1967), the explosion of the shuttle *Challenger* (January 28, 1986), and the disintegration of *Columbia* (February 1, 2003) all occurred during the same calendar week.

The quotation below is taken verbatim from the Executive Summary of the Shuttle Criticality Review and Hazard Analysis Audit Committee (SCRHAAC), formed by the National Research Council (NRC), at the request of the National Aeronautics and Space Administration (NASA), in response to a recommendation of the Presidential Commission on the Space Shuttle *Challenger* Accident (also known as the Rogers Commission).

Whew! More producers and co-producers than a Hollywood space disaster movie. From that summary:

A hazard is said to be "eliminated" when its source has been removed. A "controlled hazard" is one that has effectively been controlled by a design change, addition of safety or warning crevices, procedural changes, or operational constraints. Any hazard that cannot feasibly be eliminated or controlled is termed an "accepted risk."

If a sufficient number of management layers are superimposed on top of each other, it can be assured that disaster is not left to chance.

—*NORMAN RALPH AUGUSTINE, U.S. writer*

The space shuttle is a better and safer rocket than it was before the Challenger *accident.*

—SALLY RIDE,
U.S. astronaut

10. SAFE BACK HOME . . . SORT OF. Gus Grissom nearly drowned in 1961 when his *Liberty Bell* capsule sank after splashdown in the Pacific.

Liberty Bell 7's 15-minute ride through the stratosphere was to test improvements in astronaut equipment, including an emergency escape hatch that could be activated by firing explosive bolts. When the craft splashed down in the Bahamas, the side hatch blew, and the capsule sank, almost drowning Grissom. Navy divers rescued him, but *Liberty Bell 7* went to the bottom and wasn't recovered until 1999.

Controversy remains whether Gus blew the hatch prematurely or it was caused by some unknown reason. Grissom spent the remaining 6 years of his life insisting he had done nothing wrong. He has supporters and detractors.

The engineer who helped Grissom board the capsule, Guenter Wendt, states emphatically, "It was an unexplained anomaly. But we know that Grissom did not blow the hatch." To fire the explosive bolts, Grissom would have had to whack a plunger. The force needed to detonate would have left a bruise, which Grissom didn't have. Other ways to blow? Just one. Divers securing the spacecraft had the capability of opening a small panel on the outside and yanking a handle to rescue trapped occupants.

"That is the one that I believe in," said Wendt. "It is the most logical explanation. Can we prove it? No."

A ship in harbor is safe—but that is not what ships are built for.

—*JOHN A. SHEDD*, Salt from My Attic

11. FATE IS THE HUNTER. On January 27, 1967, Grissom died tragically with Ed White and Roger Chaffee in the *Apollo 1* launch pad fire.

The pre-flight test (for a mission originally designated *Apollo 204*) was plagued with problems with communications and oxygen. And oxygen caused the disaster. Five hours into the testing, Chaffee suddenly said, "Fire, I smell fire." Two seconds later, White shouted, "Fire in the cockpit!" Seconds later, they were dead from smoke inhalation.

Contributing to the disaster was the pure oxygen atmosphere (nearly full atmospheric pressure) and flammable objects inside the module. Under normal circumstances these would have been only mildly flammable, but in pure oxygen they blazed furiously. Did an electrical spark ignite the explosion? Analysts could find no single cause.

If one is forever cautious, can one remain a human being?

—*ALEKSANDR SOLZHENITSYN, Russian writer*

12. GET IT TOGETHER, GUYS. The $125 million *Mars Climate Orbiter* crashed on the Red Planet because the Jet Propulsion Laboratory used metric units, while engineers at Lockheed Martin used feet and pounds, in their calculations.

Nobody bats .500. We all make mistakes.

—*DESI ARNAZ, Cuban-American actor*

13. CLOSE CALL. In 1975, the U.S. half of the *Apollo-Soyuz* crew choked on toxic nitrogen tetroxide propellant during descent because pilot Vance Brand failed to deactivate the craft's thrusters. There were no casualties.

14. GIVE OR TAKE A THOUSAND: Prior to the *Challenger* disaster, NASA officials put the risk of a shuttle accident at 1 in 100,000. Physicist Richard Feynman found that the odds were more like 1 in 100.

For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.

—RICHARD FEYNMAN, U.S. physicist

15. CITIZEN ASTRONAUT. The *Challenger* accident was the 25th shuttle flight, *Columbia* the 114th.

Columbia was the first shuttle to go into operation, in 1981. Two years later she was followed by *Challenger*, then *Discovery* and *Atlantis* in 1984 and 1985.

Challenger had flown nine successful missions before its liftoff tragedy in 1986. (*Columbia* was to suffer a re-entry tragedy in 2003.) Its mission was to carry a tracking data relay satellite and to orbit the *SPARTAN-203*, a free-flying module designed to observe Halley's comet with ultraviolet spectrometers and cameras.

It was also to fly the first "ordinary citizen" into space, on the Teacher in Space program. Schoolteacher Christa McAuliffe was selected from more than 11,000 applicants and inducted into the astronaut corps. She was going along not just as a passenger or observer; she also trained as a payload

specialist, joining a varied crew: Commander Francis Scobee; pilot Michael Smith; mission specialists Judith Resnik, Ellison Onizuka, and Ronald McNair; and fellow payload specialist Gregory Jarvis.

Barely over a minute into the flight, the entire crew was lost when *Challenger* exploded.

Investigation revealed the cause of the disaster as failure of an "O-ring" seal in the solid-fuel rocket on the *Challenger*'s right side. The combination of faulty design and unusually cold weather caused superheated gases to leak through the joint and eventually burn through to the external fuel tank. A chain reaction of explosions caused the shuttle to tear apart instantly.

Only those who will risk going too far can possibly find out how far one can go.

—*T. S. ELIOT, U.S. poet*

16. SURVIVORS OF THE 2003 TRAGEDY. All seven *Columbia* astronauts died, but thousands of nematode worms, carried in canisters to study the biology of weightlessness, survived.

More multi-cellular animals are nematodes than any other group. They're good for study because they are simply structured. They have digestive, excretory, reproductive, and nervous systems (but no circulatory or respiratory system—they "breathe" by osmosis). They range in size from practically microscopic to several meters long. About 20,000 species of nematode have been classified. Surely someone out

there can name them all from memory. We are so sorry your life has come to that.

17. MAMMA MIA. Italian researchers have found that testosterone levels temporarily drop in male astronauts in space, along with a decrease in sexual desire. Some governments fund studies of death-rays.

A year-long Italian study we skimmed is titled "*Effetto della variazione del vettore gravità sulla attività gonadica in Mammiferi*" ("Effects of gravitational vectors on gonadal activity in mammals"). There is scanty knowledge of the influence of microgravity on the reproductive system. Research has spotlighted the slowdown of sperm production in primates (non-astronaut primates), the reduction of testicular mass in mice (don't go there), and now the diminution of the hematic rate of testosterone in astronauts.

"These alterations," the report synopsizes, "transient in the astronauts, reflect common symptoms of elderly men." Travel to space; grow old fast. More work needs to be done on what's happening at the cellular level when testicles are soaring through space. We trust the Italians will continue to contribute to this branch of science, as humanity's future out among the stars is certain to include reproduction of the species.

18. DISASTER WAITING TO HAPPEN. The International Space Station orbits amid 11,000 pieces of man-made space junk orbiting at 18,000 miles per hour.

And that's just the big pieces we can track. When you add up the thousands of pieces of hardware, gloves, and other

small objects sent or carried into space, the total may exceed 100,000 things 1 centimeter large or larger. A sliver of metal just 1 centimeter long, traveling at 18,000 mph, can slice through anything you care to mention. Orbiting trash is hazardous to spacecraft. Eventually a shuttle, a satellite, the space station, or an astronaut is bound to be broached by a chunk of this whizzing stuff. The consequences will be at very least unpleasant; at worst, catastrophic.

19. DISASTER AVERTED. For the record, the actual first words telling of *Apollo 13*'s distress were not "Houston, we have a problem," but "Okay, Houston, we've had a problem here." Instead of being the story of the third human landing on the moon, it became the first human survival-in-space story—with the entire planet watching in real time.

Maybe you saw the movie; maybe you're old enough to remember the real thing. On April 14, 1970, about 2 days into the mission and 200,000 miles from Earth, *Apollo*'s No. 2 oxygen tank exploded. The blast damaged other parts of the service module, including the No. 1 oxygen tank. Since oxygen tanks were needed to generate electricity, the ship's power potential was drastically—potentially fatally—reduced. Although the problem was later traced to faulty wiring, the crew initially thought the craft had been hit by a small meteorite—space isn't really all that empty.

The crew—James Lovell, Jr., John Swigert, Jr., and Fred Haise, Jr.—evacuated into the lunar module, their "space lifeboat." They deactivated all non-essential command module systems to preserve power for re-entry.

Although landing was now impossible, they continued around the far side of the moon, then made the "burn" for

home. While the world watched in agonized suspense, they worked with ground control and together improvised their way out of potentially fatal situations all the way home (see chapter on Duct Tape). Although their "lifeboat" was designed to support 2 men for 2 days, their ingenuity kept all 3 men alive for 4 days.

There are people who make things happen, there are people who watch things happen, and there are people who wonder what happened. To be successful, you need to be a person who makes things happen.

—*JAMES LOVELL, JR.,*
U.S. astronaut (Apollo 13)

20. BETTER TO BE SAFE THAN SORRY. *Apollo 13*'s originally scheduled command module, pilot Ken Mattingly, was scratched after he was exposed to measles and doctors feared he might fall ill during the mission. (The other two crew members were immune, having had measles as kids.) Mattingly later went up in *Apollo 16* and shuttle flights—and he never did get the measles. But none of the *Apollo 13* astronauts ever went into space again. Why tempt fate?

* * *

WHAT NEXT?

Because it's so closely tied to politics, the specific future of the space program is uncertain. But history suggests the inevitability of human expansion into new frontiers, despite all the risks. This goes for individuals as well as for government programs. Private enterprise has joined the surge into space and has already

suffered casualties. In July 2007, the company that built *SpaceShipOne*, the first private craft to reach space, was rocked by a mysterious launch site explosion that killed three technicians and badly injured several others. They were testing fuels for Burt Rutan's *SpaceShipTwo*—designed expressly for space tourism.

Space tourism! How quickly the unknown, the experimental, and the previously terrifying can become part of our daily lives. We may suppose that other deaths—civilian and astronaut—are inevitable. We may further suppose that this will not keep us earthbound. Humanity will continue space exploration—and not just for the scientific payoff, not just to learn what's out there. We will keep relentlessly expanding into space because at some level we understand that a one-planet species, living on an increasingly endangered planet, has only a miniscule chance of long-term survival.

So, if history is any indicator of the future, it seems inevitable that humans will continue making space shots to the planets, to other systems, to places we don't even know about yet.

That's the kind of people we are. We don't mind taking risks. To use another baseball metaphor, you swing just as hard to strike out as to hit a home run. So you might as well keep swinging.

20 THINGS YOU DIDN'T KNOW ABOUT SPERM BANKS

When sperm and egg unite, something goes from inanimate to animate. It is life.

—*MITT ROMNEY, U.S. politician*

People have been reproducing for a long time. Indeed, history is replete with references to reproduction—not only its biological aspects but its romantic ones as well. If history teaches us anything, it is to admire humanity's ability to adapt, to imagine and invent. Since we are the only species clearly aware of mortality and of the primacy of continuing our gene pool, it was just a matter of time before we began to dither around with species management.

We learned the laws of genetics, explored the mysteries of DNA, began mapping the human genome. Even as you read this, brilliant minds are designing arcane experiments in genetic engineering, recombining DNA into cross-species marvels previously unimaginable.

We leave them to their labors, turning our attention to the family level, where science is producing daily miracles outside the glare of the spotlight.

Every day, everyday people are storing their own seed against

possible futures, for reasons ranging from fear to compassion to the purely mercenary. Since their, um, conception in 1964, sperm banks have sprung up all over the world. Most of us know little about them except for a few tawdry jokes and silly urban legends. Here's an overview of the real story.

* * *

1. WHY WE GIVE. Men often bank their sperm when facing conditions they feel may threaten their future fertility, like testicular disease, chemotherapy, or medications that might impair sperm production or quality (e.g., sulfasalazine, methotrexate). Other depositors are men headed into war who wish to ensure continuity of their genes, and vasectomy candidates hedging their reproductive bets. Some even bank their sperm for money.

2. WHERE TO GIVE. There are directories to guide interested parties to sperm banks all over the country, allowing them to select the type of sperm they want. The selection of both donors and recipients is often done online these days, since most sperm banks have Web sites. Preferred donors are in their mid-20s to their late 30s, between 5'11" and 6'4" tall, in robust health, well-educated, and free of deformities, with a good family medical history. In other words, as close to perfect as is reasonably possible.

Sperm bank enrollment can be tougher than admission to Harvard. According to the *Harvard Crimson,* the college's lowest-ever admission rate was for the incoming class of 2009—only 9.1% of applicants made

the grade. The Sperm Bank of New York has an annual average of 800 applicants for donation, of whom only 12 are accepted—which translates to 1.5%. The question: were any of those 12 Harvard men?

American sperm banks are regulated by the FDA. Individual states may have additional guidelines, but none may violate federal rules. Potential donors inquire which sperm banks are accepting new donors. The bank asks preliminary questions, then arranges a personal interview at the facility. At that time the donor completes a detailed medical history about himself and his family, and discusses the bank's policies and procedures. He leaves an initial semen sample (collected then and there) for testing of quality, quantity, and how well it can be frozen. Donors commit to a contract duration and to giving a certain number of samples. They are regularly tested, and their deposits are stored and screened for at least 6 months before being released to waiting wombs.

A cryoprotectant (from the Greek *kyros*, "cold") is added to donors' specimens to reduce freeze damage. Then they are placed in individual vials, which are frozen in liquid nitrogen tanks at –196°C. (–321°F.). At this temperature, metabolic activity stops, allowing the semen to be preserved virtually indefinitely. Generally, more than half of all sperm cells survive the freezing and thawing process with their fertilization capability undiminished.

Cryoprotectants are chemical freezing solutions that can preserve living tissue, cells, or even organs at super-low temperatures for later viability. Glycols are often used to prevent cell damage during storage, just as anti-freeze protects a car's fluid systems. Biologists have discovered that mixed protectants work better than single ones because they allow for better management of toxicity levels. Arctic animals and insects create internal biological cryoprotectants against extreme cold, often based on natural sugars and glycerols in their livers or equivalent organs.

3. HOW TO GIVE. Men are considered infertile if their sperm count is below 20,000,000, which would make the likelihood of successful ovum penetration dismally low. Each sperm—from head to the end of its flailing tail—is about 0.0016 inches long. They swim an average of 30 inches an hour, and they usually survive inside the female for 72 hours (a few days more under controlled lab conditions). Each contains 23 chromosomes to combine with the woman's 23 for the total 46 needed to create a human embryo.

The average human ejaculation contains about half a teaspoon of semen, anywhere from 180 to 400 million sperm. An average sperm count is 50 million per milliliter. A man can donate sperm once every 48 to 72 hours, to allow his body time to create enough ejaculate, of sufficient quality, to be worth the trip to the lab.

It is a well-documented fact that guys will not ask for directions. This is a biological thing. This is why it takes several million sperm cells . . . to locate a female egg, despite the fact that the egg is, relative to them, the size of Wisconsin.

—*DAVE BARRY, U.S. humorist*

4. SAVING FOR A RAINY DAY. Fort Collins, Colorado, is the site of the National Center for Genetic Resources Preservation (NCGRP), the world's largest seed collection, established to preserve the "genetic resources of crops and animals important to U.S. agriculture and landscapes." Besides our backup gene supply, across the planet are sperm banks for koalas, elephants, yaks, chimpanzees, and other useful creatures.

Australian scientists set up the world's first koala sperm bank after producing three test-tube cubs. Thailand founded the world's first elephant sperm bank and has patented a technique for freezing and thawing elephant sperm. It costs about $51,000 to artificially inseminate a female elephant, and only three elephants have ever been born by artificial insemination. The Shanghai Zoo's tiger sperm bank will help endangered South China tigers avoid extinction. And China opened the world's first yak sperm bank, in Tibet, in 1994.

The mental picture of harvesting yak semen is staggering. Hand me the gloves, Dr. Tang. For relief we turn our attention to the more familiar process—for most readers, at least—of extracting *Homo sapiens* semen. Sperm banks provide discreet private rooms and visual aids for on-the-spot collection. While no sperm bank yet offers the equivalent of semen ATMs, donors can opt for depositing at home in sterile containers, provided the sample can arrive at the lab within an hour of production.

The only jobs for which no man is qualified are human incubators and wet nurse. Likewise, the only job for which no woman is or can be qualified is sperm donor.

—*WILMA SCOTT HEIDE, U.S. feminist*

5. WOMEN DO IT, TOO. According to *China Daily*, in 2004 Beijing's First Hospital, affiliated with Peking University, established the first ovum bank for women who, for career or other reasons, prefer to postpone having a child. As with sperm banks, cryotechnology permits safe long-term egg storage. The China bank requires detailed data about donors—blood type, age, education, physical features, personality traits, and place of origin.

There is also an epidemic of infertility in [the U.S.]. There are more women who have put off childbearing in favor of their professional lives. For them, the only way they are going to have a family is to adopt from China.

—*IRIS CHANG, U.S. writer*

As we see from the above, there is really another viable option, thanks to sperm and ovum banks.

On December 31, 2005, Avery Lee Kennedy was born in a Kentucky hospital. At 8 pounds, 2 ounces, Avery was the first baby born after being conceived with a frozen donor egg from an egg bank. The first commercial egg bank is called Cryo Eggs International.

Artificial insemination (AI—not to be confused with artificial intelligence) is the surgical planting of sperm into a woman's cervix or uterus, either in the absence of normal reproductive functions or by the choice of a woman ready to become a mother. This can be done with the sperm of the woman's partner, by a known third party, or by an anonymous donor who meets certain criteria.

In the past, the semen of a (possibly sterile) husband and another donor were mixed for social, not medical, reasons. This allowed for the possibility (or the fiction) that the resulting child was sired by the husband, since it was difficult in pre-DNA days to prove otherwise. Fertilization by donor alone raised moral and legal questions. Some claimed that artificial insemination was tantamount to adultery and that any child born of the process was therefore illegitimate.

Artificial insemination was originally developed for animal husbandry.

6. IN VITRO VERITAS? Human in vitro fertilization (IVF) is the process of fertilizing an ovum outside the woman's body—in a lab—with live sperm. The procedure was first successfully performed on Lesley Brown in England in 1978 by a gynecologist-embryologist team (Drs. Steptoe and Edwards). Since then, the process has been significantly refined, producing over 20,000 babies in many countries. The success rate continues to improve, although a viable pregnancy can never be 100% guaranteed, since so many factors contribute to success.

Each year thousands of embryos, no bigger than the head of a pin, are created in the process of in vitro fertilization, with the support of Congress, by the way.

—LOIS CAPPS, U.S. congresswoman

Sperm is kept frozen for 6 months to test for diseases. Donors are selected on the basis of their sperm motility—med-speak for "friskiness." Only strong swimmers need apply. According to the American Society for Reproductive Medicine, a donor is selected if the semen has a motility of 20 million to 30 million sperm per milliliter.

7. SMART SPERM. In 1980, California philanthropist Robert Graham opened the Repository for Germinal Choice, nicknamed the Nobel Prize Sperm Bank because it stocked samples from brainy scientists, including several Nobel laureates. William Shockley, 1956 Physics Nobel Prize winner (he co-invented the transistor), was the sole member of that fraternity to publicly admit contributing. For 19 years the bank accepted deposits, producing over 200 children. The first

two "Nobel babies" were Victoria Kowalski and Doron Blake. In 1997, at the age of 90, Graham died while on a semen-collecting trip. He fell and drowned in a hotel bathtub. It is not known whether he was attempting a donation at the time.

8. MOMMY AND MOMMY. When lesbian couples decide to become parents, many choose biological motherhood over adoption. Some self-source the sperm (from known persons, often gay men); others turn to fertility clinics for insemination via anonymous donors. Sometimes lesbians experience discrimination from health care providers or insurance plans, since some legal systems still claim that "proper parenting" requires parents of both genders.

All women, lesbian or straight, need sperm to make babies. Lesbian Web sites recommend sperm banks because they screen semen for HIV and other diseases. And the recipient never has to worry about the father coming after her child, since donors agree to waive all parental rights (and also responsibilities). Although most sperm banks are set up for married and other straight couples with fertility issues, others understand the needs of lesbians or single women who wish to exercise the motherhood option. The challenge for gay women is to find a lesbian-friendly environment.

For women interested in self-insemination, there are many Web sites, some connected to delivery services from sperm banks that will ship anywhere in the U.S. Other banks, depending on local laws, ship outside the U.S. (Some states restrict sperm delivery to authorized medical offices.)

9. COULD THIS HELP OUR TRADE DEFICIT? The U.S. is the No. 1 sperm exporter. Four of the five world's largest sperm banks are here. And donors make decent bucks. Example: California Cryobank (which stores ova also) offers sperm donors up to $1,000 per month if they are 18 to 38 years old, attend a 4-year university, or have a degree and live close enough for a year-long commitment of two to three deposits a week (and pass a rigorous medical screening). An anonymous donor giving about half a dozen times a month earns from $900 to $1,100. (Non-anonymous donors earn 20% more.) One donor claimed earnings of $7,000 in 1999 from ejaculations alone. What a guy! Donors must decide whether or not to report sperm earnings to the IRS. Clearly, sperms cannot be declared as either dependents or employees—even when they are working hard for you.

10. PARTY POOPERS. The Canadian government recently made it illegal to pay men for donating sperm. (Could starch-collar prudes view it as prostitution?) Payments were previously $75 per donation. It is currently OK to import Yank sperm, but since the Canadian semen supply was shrinking to a trickle, Ottawa intends to re-legalize payment. This should induce Canadian men to pony up, as it were. The U.K. has also had a problem with donor dropoff ever since 2005 legislation enabled children over 18 to learn the identity of their donors.

In Britain, Sweden, Norway, and the Netherlands, it is illegal to sell anonymous sperm. Sweden, Austria, and the state of Victoria in Australia have mandatory donor identification release.

When a Canadian woman became infected with *Chlamydia* after receiving donated sperm, 35 of Canada's 49 sperm banks were quarantined. This resulted in a sperm storage shortage among our neighbors to the north. It's estimated that Canada spent between $3 million and $5 million to import U.S. sperm.

With regard to donations, always expect the most from prudent people, who keep their own accounts.

—JOSEPH ADDISON, British essayist

11. YOU CAN FATHER CHILDREN EVEN AFTER YOU'RE DEAD. Sperm have a long shelf life (they can legally be stored for 40 years if the right temperature is maintained). There are cases of successful births from sperm over 20 years old. This longevity factor is psychologically comforting to some men, knowing that whatever may happen to them, their sperm is safely locked away somewhere, waiting to spring their DNA into the future, either via their wife or under some other family's name.

12. BEWARE OF SPERM SCAMS. Joey Skaggs (aka Giuseppe Scaggoli), the self-proclaimed world's greatest hoaxer, hyped the media and the citizenry of New York City in 1976 when he announced the opening of a "celebrity sperm bank," which would auction off the semen of rock stars Mick Jagger, Bob Dylan, and Paul McCartney (all of whom have subsequently proved that they can produce semen). He attracted a crowd of screaming fans craving star sperm—and also morality-minded protesters and frothing feminists. When the doors

opened, Skaggs was "shocked" to discover that the sperm had been "stolen."

In most places around the world, it is generally accepted that if a donor remains anonymous, he is free of any responsibility to the biological offspring produced by his sperm, or for child support. This has occasionally been challenged.

13. YOU STOLE MY WHAT? A reproductive rights case involving sperm "theft" involved two doctors, male and female. After consensual oral sex, the woman secreted her partner's semen and, unbeknownst to him, impregnated herself with it. As he had no desire for fatherhood, he sued her for mental distress. Her position: the sperm was a gift, given willingly, which she had no reason to expect he would want her to return to him. She could therefore do with it whatever she wished, including using it to start a baby. His point: no reasonable person, especially a physician, would reasonably expect pregnancy to result from oral sex, and he had been defrauded. The case is under court review.

In Sweden, where artificial insemination is illegal outside the public health care system (and where it was previously available only to heterosexuals), a Stockholm court ordered a man to pay child support to a lesbian couple whose three children his sperm donations produced.

At the University of Florida, in 2006, a refrigerator that was storing sperm rose in temperature, and thousands of samples—hundreds of billions of sperm—were destroyed. This translates into the loss of unimaginable millions of potential new people.

14. HOME STORAGE? A sperm breakthrough in 2003 is the air drying—instead of deep freezing—of semen. This suggests the possibility of easy storage at home, even of transporting banked semen from one location to another. Sperm, efficient little self-protectors, coat their DNA so well that they can be dried out, sealed up, and kept at room temperature. It was previously believed that sperm died when exposed to air because they lost motility. But it turns out that they are just playing possum. Studies now show that air-dried sperm can fertilize ova, and early-stage embryonic cell division is not impaired. "With . . . intracytoplasmic sperm injection (ICSI), the loss of motility doesn't necessarily mean the loss of ability to fertilize an egg, since this is largely dependent on the DNA . . . tightly packed into the sperm head. We believe our study confirms that sperm DNA is resistant to damage by air drying," says Dr. Daniel Imoedemhe, researcher at the Centre for Assisted Reproduction in Jeddah, Saudi Arabia.

An interesting sidelight is that freezing sperm is costly, while almost anyone can let semen dry at home. However, if sperm storage is so cheap, easy to do, and therefore widely accessible (not sealed in huge liquid nitrogen vats), there may be greater potential for sperm theft.

15. GOT A PACKAGE FOR YOU. Some fertility services provide mail-in kits for sperm donations. Web sites offer prompt same-day semen delivery to paying customers.

16. HE SHOOTS; HE SCORES! In 1995, according to the American Society for Reproductive Medicine, intracytoplasmic

sperm injection resulted in 1,659 pregnancies and 1,350 births in the U.S. In 1998, the last year statistics were kept, the numbers dramatically increased to 9,361 pregnancies and 7,712 births.

17. GET MY INSURANCE PEOPLE ON THE PHONE, PLEASE. Since fertility (testing, procedures, storing) can be expensive, the natural question is, Will my insurance cover this? The short answer is that some will and some won't. It all depends on the terms of the individual plan, the interpretation of those terms, and local health coverage laws.

Example: the state of Illinois requires all group insurance plans and HMOs to cover diagnosis and treatment of infertility the same as any other physical condition. They may not assess surcharges of additional co-payments or deductibles for infertility coverage. Subscribers therefore get benefits for (among others) fertility testing, prescriptions, artificial insemination and in vitro fertilization, gamete intrafallopian tube transfer, intracytoplasmic sperm injection, donor sperm and egg medical costs, and more.

18. THERE ARE SOME NAYSAYERS. Philosophy aside, how does a recipient know what she's getting into until it's too late? Donors file detailed personal and family medical histories. But all self-reporting is unreliable. Any respondent could be lying, deluded, forgetful, or simply mistaken about facts. And although screening can detect diseases, sperm defects, and other undesirable physical factors, there is no sure way to spot genetically transmitted mental disorders—if such exist.

It is unclear whether there is a biological predisposition to

(for example) bipolar disorder, schizophrenia, or other psychoses that seem to "run in the family." How much is genetic; how much is passed down behaviorally? We can reasonably suppose that some personality disorders are caused by a combination of biological predisposition and environment.

A donor could father many children before his mental illness blossoms. This is why some countries or states prohibit donor anonymity, as seen previously. Others guarantee children the legal right to track their biological parents.

Although statistics make it astronomically unlikely, some observers worry that the child of an anonymous donor might marry another sired by the same donor, unwittingly committing incest. Well. Please. It's a stretch, but some people do factor that into their decision.

19. SUSHI, CORN, AND SPERM. The world's first two sperm banks opened up in 1964 in Tokyo, Japan, and Iowa City, Iowa.

20. DONOR NO. 3066. Of the seven known children this man fathered (sperm came from the California Cryobank in Los Angeles), two have autism, two are sensitive to noise, and one hates wearing clothing with tags.

* * *

WHITHER FERTILITY?

This thoroughly incomplete review of human seed banking raises a number of questions. We know the biology and the technology work. But—as suggested above—what about the ethical

dimension? Is it morally acceptable to manipulate Mother Nature just to become a mother?

Ethics, too, are nothing but reverence for life. This is what gives me the fundamental principle of morality, namely, that good consists in maintaining, promoting, and enhancing life, and that destroying, injuring, and limiting life are evil.

—*ALBERT SCHWEITZER,*
Alsatian medical doctor

It seems to come down to a simple idea. We are dealing with the basic choices of donating life and of bearing new life. Whatever we may think about methods, techniques, motives, or morality, all we can finally do is remain awed by the underlying mystery of reproduction, and welcome and celebrate the miracle of the human lives that it brings to us.

What a privilege to be here on the planet to contribute your unique donation to humankind. Each face in the rainbow of colors that populate our world is precious and special.

—*MORRIS DEES, U.S. lawyer*

20 THINGS YOU DIDN'T KNOW ABOUT WEATHER

Everybody talks about the weather, but nobody ever does anything about it.

—MARK TWAIN, U.S. humorist

Well, yes, they do. Fact is, throughout history, people have often tried to do something about the weather.

No place on earth, no matter how privileged, is without weather. Since earliest times, we have seen the role it plays in our daily lives. We take weather very personally because of its impact on our daily lives, our moods, our work. Recreation, entertainment, sports and other outdoor events, travel, school attendance, transportation, commerce, and agriculture—they're all affected by weather.

This being the case, one of the first things we do about the weather is try to predict it.

Primitive attempts to anticipate and to influence weather have included watching clouds, sniffing wind, studying bird flight and the thickness of animal fur, propitiating Sun gods with flesh sacrifice, dancing, singing, and otherwise performing to encourage rain gods to moisten crops.

Modern climatologists and meteorologists seek to relieve droughts by seeding clouds for rain. They use satellite photog-

raphy and advanced computer modeling to try to discern medium- and long-term weather patterns. But for all our technological and cybernetic wizardry, it's still a turkey shoot. Sometimes the weather throws us a curve.

Here's a scientific perspective on why forecasting is so hard:

> Imagine a rotating sphere . . . 12,800 kilometers (8,000 miles) in diameter, . . . bumpy surface . . . surrounded by a 40-kilometer-deep mixture of different gases whose concentrations vary both spatially and over time, and is heated . . . by a nuclear reactor 150 million kilometers (93 million miles) away. [. . .] [Earth is] revolving around the nuclear reactor and that some locations are heated more during one part of the revolution and other locations are heated during another part of the revolution. And . . . this mixture of gases continually receives inputs from the surface below . . . sometimes through violent and highly localized injections. Then, imagine that after watching the mixture, you are expected to predict its state at one location on the sphere one, two, or more days into the future. This is essentially the task encountered day by day by a weather forecaster.
>
> —*BOB RYAN,* Bulletin of the American Meteorological Society, *1982*

Weather forecast for tonight: dark. Continued dark overnight, with widely scattered light by morning.

—*GEORGE CARLIN, U.S. comedian*

* * *

1. *PLUS ÇA CHANGE, PLUS C'EST LA MÊME CHOSE.* Around 650 B.C., the Babylonians predicted weather from cloud patterns.

Other sources cite the Chinese around 300 B.C. studying clouds and rainfall to predict future weather for farmers and travelers.

Among the first meteorologists were the ancient Greeks. They even invented the word "Meteorology," a compound of *meteron* (in the sky) and *logos* (knowledge). Even great philosophers get rained on occasionally. Aristotle (384–322 B. C.) was an avid student of earth science and atmospheric phenomena. His treatise "Meteorology" also deals with the water exchange cycle.

He discusses winds, earthquakes (which he thought were caused by underground winds), thunder, lightning, and rainbows, as well as meteors, comets, and the Milky Way (which he thought were atmospheric phenomena).

In more modern times, pioneer meteorologist H.W. Brandes, of Leipzig, Germany, published maps of notable European storms in 1820 and 1821, based on data he assembled and interpreted.

2. BLOWHARD. In New York, William C. Redfield (1789–1857) expounded his theory that storm winds blow counterclockwise around a center that follows the general direction of the prevailing winds. Redfield had worked on this idea for 10 years, since the great New England hurricane of September 1821, whose path he charted, carefully noting tree damage patterns. Redfield's extensive work on hurricanes thus revealed both their rotary and their progressive pathways.

Down the road in Philadelphia in 1825, James P. Espy published the results of his own studies on thunderstorms and tornadoes. In 1842, he became official meteorologist to the federal government. Working in the office of the Surgeon General of the Army, he prepared weather maps for the military.

3. HEY, LET'S JUST CALL OFF THE BATTLE. Since the earliest recorded wars, weather has affected the outcome of battles—even entire campaigns. Sudden storms or fog can impede the view of enemy positions. Rainfall muddies battlefields and roads, impeding the movement of men and material, often trapping tanks and trucks in muck. In the early days of firearms, wet weather made gunpowder useless. The savage cold of the Russian winter destroyed Napoleon's army more quickly and completely than any army ever did. During the Battle of the Bulge in the winter of 1944, days of cloud cover frustrated attempts by the Army Air Corps to provide air support to trapped American troops.

Indeed, the launch order for the D-Day invasion of Normandy depended on precise calculations involving wind, tides, cloud formations, and moonlight.

4. DIT DAH DIT, DIT DAH, DIT DIT, DAH DIT. In 1849, responding to the appeals of weather scientists, the Smithsonian Institution authorized the use of the "new" electric telegraph for sending timely weather information across the country. The Smithsonian began drawing up compilation maps soon thereafter, making them available to the public around 1853.

Telegraphic data collection quickly spread to Europe.

5. THEY HAD AN AIR ABOUT THEM. Two meteorologists whose names are enshrined in weather nomenclature are Admiral Sir Francis Beaufort (1774–1857), a self-educated Irish cartographer who devised the Beaufort Wind Force Scale we still use to measure hurricanes, and his protegé, Robert FitzRoy (1805–1865), known for the FitzRoy barometer.

Both men built their careers at sea as naval cartographers and officers in the Royal Navy. Captain (later Admiral) FitzRoy's fate was to navigate the *Beagle*, the ship on which Charles Darwin sailed around the world for nearly 5 years while collecting material for *The Origin of Species*. FitzRoy barometers were set up at data collection stations around the world.

The basic instruments used for compiling weather data are these:

Thermometer—a glass tube that contains some substance (e.g., alcohol, mercury) that expands or contracts at a known rate according to the temperature. Markings on the tube show the temperature in numerical form as degrees.

Barometer—a glass tube, open at the top, with a mercury reservoir at the bottom, whose level adjusts to atmospheric pressure. The mercury in the tube balances outside atmospheric pressure. Air has weight. So high pressure (good weather) exerts more gravitational force on the reservoir, pushing the mercury higher up the tube. Low pressure (bad weather) makes the mercury drop lower. There are other barometers; the mercury version was first developed in Italy by Evangelista Torricelli in 1643.

Psychrometer—measures relative humidity with two thermometers, one of which has a wet cloth placed over the end. As the water evaporates it lowers the temperature on the moistened thermometer. The cooling effect is calculated by comparing the two.

Anemometer—measures wind speed on a dial as the wind rotates the cups or other air-catching device.

Weather balloons carry a variety of instruments to measure upper atmosphere weather conditions, and satellite and other space-based instruments use infrared and other photography, and computer modeling, to track and predict longer-range patterns.

6. OR MAYBE IT WAS JUST THAT AWFUL ENGLISH WEATHER. A devout Christian, Robert FitzRoy was understandably upset with his unwitting participation in "undermining" the biblical account of creation by captaining the *Beagle* with Charles Darwin aboard. Despite his own remarkable career and many contributions to meteorology, Darwin's fame had greatly eclipsed his own. One morning in 1865, FitzRoy slipped away from his family and cut his throat with a razor. Could it have been that depressing English weather?

The U.S. Army Signal Corps established a weather tracking service shortly after the Civil War (1870), which later became the U.S. Weather Bureau within the Department of Agriculture, finally being absorbed into the Department of Commerce.

7. WHAT'S IN A NAME? The U.S. Weather Bureau, now N.O.A.A.'s National Weather Service, works within the National Oceanic and Atmospheric Administration. Its nerve center in Maryland, the National Meteorological Center (NMC), collects and interprets weather data of all sorts from a great many outposts across the country.

FOLK WISDOM ABOUT WEATHER

Because we take weather so personally, there are many folk sayings about it. Some are absolute hogwash; others are scientifically explainable. Here are some traditional examples, for better or worse:

Geese (and other migrating birds) fly higher in good weather. True! The higher you go, the lower the air pressure, and migrating birds need altitude.

Cow's tail to the west, weather the best; cow's tail to the east, weather the least. Say what? Cows can't read a compass. But this old proverb is based on science. Animals tend to graze with their backs to the wind. Since an east wind is more likely to bring rain, and a west wind good weather, the cow's tail acts as a furry weather vane.

Thicker-than-usual corn husks mean a cold winter is on the way. There's no evidence to prove or disprove this, since corn can't think ahead. It's probaby more a function of rainfall and soil conditions earlier in the season than of prognosticative skills on the part of corn plants.

The higher the clouds, the better the weather. In general, this has a scientific basis in the fact that clouds float higher when dry air and good barometric conditions prevail—both conditions associated with fair weather.

When ants run straight, rain is coming; when they scatter, good weather is in store. What? No scientific evidence supports this loopy notion. What ants do is probably linked to their determined quest for food or to other ant agendas, not to atmospheric conditions, which must be far from an ant's consciousness.

Flies bite more before a rain. Indirectly true. Insects find flying harder when the air is heavy with moisture. They'd rather land and sup on moist flesh.

Bees will not swarm before a storm. This is largely anecdotal. Experience shows that bees will swarm whenever they feel like it.

Crickets chirp faster in warm weather. Unlikely, but true. These little guys, who chirp by rubbing their legs together, are fairly accurate thermometers. Formula: count chirps for 14 seconds, add 40, and you have the local temperature in Fahrenheit. Imagine—someone bothered to figure that out.

When leaves are backward in the wind, bad weather is coming. Absolutely true. Trees grow in the prevailing (fair-weather) wind. In cyclonic (non-prevailing) wind, leaves are blown against their natural pattern and show their backsides.

When squirrels store up lots of nuts, look for a hard winter. This is plain nonsense. We're projecting human planning skills into a small furry animal. Squirrels neither think ahead nor read *The Farmer's Almanac.* They just go for all the nuts they can get. And some seasons are nuttier than others.

8. MUST BE THOSE DARNED SMOKESTACK-HUGGERS. The broader macro-version of weather is the planetary climate, otherwise known as the environment. Scientists refer to the issue as anthropogenic global warming (AGW)—a dignified way of saying that human activities are heating up the planet.

Many countries are embroiled in an acrimonious debate on AGW, setting political and environmental activists aflutter. Each faction presents scientific evidence, real or imagined, to bolster its position. In the broadest sense of the word, most people would like to do something about long-term weather and for the survival of planet Earth. Weather in this sense has become a hot-button political issue.

Volcanoes and natural biological processes can produce natural weather-affecting emissions. But over the past 150 years, weather has been increasingly altered by human activities. Beavers, bees, and ants, for all their hard work, have never established carbon-burning enterprises.

9. PASS ME THE TITANIUM UMBRELLA. Acid rain is caused mainly by sulfuric and nitrogenous gases and particles spewed aloft by motor vehicles, power generators, and factories. When they rain back down to Earth, they re-enter ground water and can cause illness to aquatic life through acid buildup. Acid rain is an equal opportunity nuisance, falling on (and often adversely affecting) forests, the soil and what grows in it, and even public buildings and ancient monuments. It speeds up oxidation on iron and is a generally corrosive factor.

Does pollution cause bad weather, or vice versa?

There are some interesting relationships between weather and pollution, one of the best . . . understood is smog. Smog happens in cities when a layer of cold air traps warmer air underneath, along with all the pollutants. . . . This accumulation can affect the health of humans by exacerbating respiratory disease. . . . I know of no case where pollution actually causes meteorological events; it is more of an interactive relationship. When bad weather and pollution happen at the same time, it seems worse to us than if either one happened alone.

—*DON LIBBY, writing on the Web site Ask a Scientist*

10. WE DO HAVE THE FOGGIEST. Argentia, Newfoundland (Canada), is by all accounts the foggiest place in North America, averaging 200 fogbound days a year. In 1936 they logged a claustrophobic 230 foggy days. Cape Disappointment, Washington, is the foggiest place in the U.S., with 106 days of fog annually. The East Coast record is Moose Peak Lighthouse in Maine, with an average of 66 days a year.

11. EVEN MILDER THAN THE CIGARS. Gran Canaria (Canary Islands) boasts of having the "best climate" with the least year-round variation of temperature (68 to 77 degrees F, or 20 to 25 degrees C) and some 300 totally sunny days a year. But the world record for most uninterrupted sunshine goes to the eastern Sahara Desert, with 4,300 hours a year of Old Sol blazing down—97% of the possible maximum. (Does the eastern Sahara observe Daylight Saving Time?)

12. ANOTHER REASON TO GO WEST. The U.S. gets most of the world's tornadoes, which are nearly always east of the Rockies, in spring and summer, because of the tinderbox combination of flat prairies and extreme air temperature differentials. These events happen predominantly in "Tornado Alley"—an area that stretches from central Texas and cuts a swath hundreds of miles wide all the way to the southern border of North Dakota.

No continent but Antarctica is untouched by them. The deadliest known tornado struck Shaturia, Bangladesh, on April 26, 1989, killing at least 1,300 people.

According to the National Oceanic and Atmospheric Administration, about 800 tornadoes are reported nationwide in the U.S. in an average year, resulting in 80 deaths, 1,500 injuries, and great loss of property.

The most costly tornado "epidemic" in U.S. history outbreak was early in May 1999 in Oklahoma, when over 65 tornadoes touched down across the state. The largest one was clocked at well over 300 mph centrifugal speed, the highest ever recorded. It demolished some 10,500 structures, claimed 42 victims, and caused $1.1 billion in damages.

13. TALK ABOUT YOUR SPIN. The centrifugal speed record for tornadoes—a snappy 318 mph—goes to the twister that bashed Oklahoma City on May 3, 1999. The briskest non-tornado wind gust on record was measured on April 12, 1934, at Mt. Washington, New Hampshire. With a top speed of 231 mph before the gauge blew away, it was probably a good day to keep a low profile.

Rainy days and Mondays always get me down.
—PAUL WILLIAMS AND ROGER NICHOLS (recorded by The Carpenters, 1971)

Rain is one weather element that can be romantic as well as annoying, depending on whether or not you can stay indoors cuddled up with a good book or are trapped in rush-hour traffic with a broken wiper blade.

14. SPLOOSH. The fiercest rainfall officially recorded was in Barst, Guadaloupe, on November 26, 1970, when 1.5 inches streaked down in 1 minute—barely time to get umbrellas out. The most rain in 1 day was 73.62 inches on March 15, 1952, at Cilaos on La Réunion Island in the Indian Ocean. (That's over 6 feet worth of H_2O from above!) But Mount Waialeale, Hawaii, floats home the gold for most cumulative yearly rainfall, with an average of 472 inches!

Depending on air temperature and the wetness of the snow, on average, 1 inch of water is the equivalent of 10.0 inches of snow.

15. CONTINENT OF CONTRASTS. The rainiest city in the world is Buenaventura, Colombia, which receives 265.47 inches a year. But down the South American coast is the driest inhabited place on Earth, Chile's Atacama Desert, which gets less than 1 millimeter of rain a year—barely enough to moisten a thimble. Great market potential for bottled water companies.

WEIRD PRECIPITATION

It has never rained cats and dogs, but it has rained frogs, toads, fish, and birds. Whirlwinds, waterspouts, and tornados are given as the explanation.

Source: Carnegie Library of Pittsburgh

For centuries there have been reports of odd things falling from the sky. Often these are toads or lizards, presumably swept into the upper atmosphere by violent ground winds only to fall back down in a rainstorm. But why would the wind be selective? Why any one particular animal, instead of all others present during the whirlwind?

16. BLOODY WEATHER. In August 1841, scientists identified a shower of not only blood but also muscle and fatty tissue (human? animal? other?) that rained onto a tobacco farm near Lebanon, Tennessee. According to the *American Journal of Science*, field workers reported hearing a rattling noise during the event, and claimed to see blood falling from a reddish cloud passing overhead.

In 1869, a farmer named Hudson in Los Nietos, California,

reported that scraps of flesh and blood rained onto his land for several minutes.

Bloody weather! More blood, possibly from shredded birds high above, sprinkled the town of Messignadi in southern Italy. No feathers, no beaks. Just blood. No explanation from the journal that reported the 1890 incident, *Popular Science News*.

During an 1881 thunderstorm in Worcester, England, an estimated several tons of hermit crabs and periwinkles dropped from the sky. It is not clear whether the periwinkles in question were flowers or snails.

Swamps in the sky? In 1877, yet another farmer, J. L. Smith, attested that several small alligators fell onto his South Carolina farm. According to the *New York Times*, they survived the fall and crawled off into the fields. (Did their ancestors end up, a century later, as giant albino gators in the sewers of New York?)

And for you vegetarians, tons of corn kernels were reported to have dropped onto several houses in Evans, Colorado, between 1982 and 1986. Oddly, there are no cornfields anywhere in the area. Why just the kernels? Greengrocers are stumped. Years later, in 2001, as if to compensate, dried corn husks—but no kernels—dropped onto downtown East Wichita, Kansas. Yes, there are cornfields in Kansas.

Color me creepy. There are many reports of odd-colored precipitation. As reported in *USA Today* on February 17, 2006, a dark chocolate-colored snow fell on parts of Colorado, attributed to atmospheric dust from a windstorm in Arizona.

In 2001, Kerala, India, was doused by a red rain containing mysterious tinted microbes that seem to have no DNA and are theorized by some to be unicellular life from outer space.

No matter how rich you become, how famous or powerful, when you die the size of your funeral will still pretty much depend on the weather.

—*MICHAEL PRITCHARD,*
U.S. motivational speaker

17. SOME LIKE IT HOT. "And tomorrow's weather will seem warm . . ." would have been a hilarious understatement by the weatherman in El Azizia, Libya, on September 12, 1922. The following day, local thermometers topped out at 136 degrees F (58 degrees C). But the highest average annual temperature was in Dallol, Ethiopia: a scorching average of 95 degrees F (35 degrees C) between 1960 and 1966. The hottest continuously inhabited place in the world is Djibouti, where the average yearly temperature is 86 degrees F.

Death Valley in California has often claimed the world's hottest temperature, with a searing surface temperature of 134 degrees F (56.7 degrees C) on July 10, 1913. The same location reported 43 consecutive days over 120 degrees F (48 degrees C) in 1917.

Don't knock the weather. If it didn't change once in a while, nine out of ten people couldn't start a conversation.

—*KIN HUBBARD, U.S. humorist*

Antarctica is typically cited as maintaining the planet's coldest average annual temperatures. It also holds the record for the lowest surface temperature ever recorded on Earth, at Vostok Station on July 21, 1983. That cold snap bottomed out at –129 degrees F (–89.4 degrees C). According to other

reports, this may have been rounded out downward from –128.6 degrees F (–89.2 degrees C). Clearly a day for gloves.

An earlier report in *Antarctic Facts* (1999), not confirmed, claimed a temperature of –132 degrees F (–91 degrees C). If true, the ground was colder than dry ice.

18. COLD CUTS, ANYONE? The lowest year-round temperature on Earth is at the appropriately-named Pole of Inaccessiblity, Antarctica, which bottoms out at –72 degrees F. The chilliest inhabited area is up in Norilsk, Russia, where the average year-round reading is only 12.4 degrees F.

And it can get mighty cold indoors, especially if you have the right lab equipment.

For years scientists have tried to create absolute zero, the lowest possible temperature, –459.67 degrees F (–273.15 degrees C). At this temperature, no radiating energy is present in matter because all molecular motion stops. This is theoretically unattainable in the physical world, but you can't blame a guy for trying. In 1987, physicists devised a way to lower atomic temperature to one ten-millionth of a degree Kelvin above absolute zero by trapping atoms with laser beams. In 1997, after patenting the idea, Steven Chu and his collaborators, Claude Cohen-Tannoudji and William Phillips, were awarded the Nobel Prize in physics.

The Fahrenheit scale is named for its inventor, the German physicist Daniel G. Fahrenheit (1686–1736). Anders Celsius (1701–1744), a Swedish mathemetician, developed what we also call the Centigrade scale,

based on the respective freezing (0 degrees C) and boiling (100 degrees C) points of water.

19. CHILL, MAN. Scientists at the Low Temperature Laboratory at the Helsinki University of Technology managed to reach one two hundred eighty trillionths of a degree above absolute zero, and in 2000 plummeted even lower, to an unimaginable tenth of a trillionth of a degree Kelvin above absolute zero (100 pK, or –0.000,000,000,1 degree C).

20. JUST MAKE SURE YOU HAVE NICE HAIR. Not many TV weather personalities are scientists, any more than traffic reporters are Formula One drivers. They are, in fact, usually personalities who got their foot in the door, hoping for a better gig as on-camera reporters or, better yet, game show hosts or anchor people.

* * *

DOES FORECASTING HAVE A FUTURE?

During May and July of 2007, more rain fell on the British Isles than in any comparable period since the U.K. began keeping records in 1766. Is this another sign of global climate change? One British climatologist, Dr. Peter Stott, puts it this way: "The past is no longer a guide to the future. We no longer have a stationary climate." So if the climate—the long-term weather pattern—isn't stationary, where's it going?

Anybody's guess. Despite all our deep computer modeling, high-altitude jet stream research, and satellite photography,

nobody knows for sure. Still, Dr. Stott's researchers believe they can show that artificial greenhouse gas emissions are affecting the global climate, creating wetter-than-normal conditions in latitudes above 50 degrees north (much of northern Europe).

Other scientists aren't even sure that any long-range predictions are likely to be reliable. As just one example, University of Delaware professor Daniel J. Leathers, who is also the state climatologist, checked worldwide records of El Niño dating back 100 years. He notes "some of the coldest winters were seen during El Niño years . . . but also some of the warmest, some of the driest and some of the wettest." The future of all forecasting seems linked to advances in computer modeling. That said, for the near future, weather scientists—like historians, epidemiologists, and others who seek causal relationships—appear destined to plod along, get the best information available, and then take their most educated guess.

Weather forecasting in this country is dictated by news directors. If a competing station is predicting calamity viewers are going to switch, so it's time to dire up your own forecast to keep them. . . . Weather forecasting has become a fast-food science.

—*LEE GRENCI,*
Department of Meteorology,
Penn State University

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With more than five million readers, *DISCOVER* is the leading science magazine aimed at the general public. Founded in 1980, this award-winning magazine publishes articles covering science, technology, and the future. *New York Magazine* called *DISCOVER* "the science magazine for the interested layman," and the *Chicago Tribune* said *DISCOVER* "is the science magazine for anyone who flunked eleventh-grade biology. It tackles topics ranging from global warming to black holes to Neanderthals with a refreshing lack of academic jargon."

DEAN CHRISTOPHER is a regular contributor to *DISCOVER*, writing book reviews and contributing to the very same column, "20 Things You Didn't Know About," that inspired this book. He has also served as editor-at-large for *SPIN* magazine and as a contributor to *OMNI*. Dean's constant yearning to learn has led him to become fluent in French and Spanish. He also spent a decade as a pianist, arranger, and composer in New York, Paris, and Madrid. Dean currently lives in Beverly Hills, California.

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